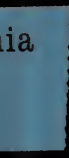

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MEDICAL OPHTHALMOLOGY

To

THE MEMORY OF

WALTER HAMILTON HYLTON JESSOP

AND TO

WILLIAM THOMAS HOLMES SPICER,

MY TEACHERS

IN AFFECTIONATE REGARD.

MEDICAL OPHTHALMOLOGY

BY

R. FOSTER MOORE, O.B.E.,

M.A., B.Ch. (Cantab.), F.R.C.S.

ASSISTANT OPHTHALMIC SURGEON, ST. BARTHOLOMEW'S HOSPITAL.
SURGEON, MOORFIELDS EYE HOSPITAL.

WITH 80 *ILLUSTRATIONS.*

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PREFACE

In the following pages an attempt has been made to give a concise account of those pathological conditions of the eyes and their connections which, for the most part, are of interest in general medical diseases.

As regards my personal opinions and observations, they are in great measure the results of investigations carried out during the last nine years in the medical wards of St. Bartholomew's Hospital.

The changes are chiefly considered under the heads of separate diseases; in Chapter I., however, I have collected together for separate consideration a heterogeneous group of important ophthalmological signs and symptoms without special reference to the diseases with which they are connected.

The subsequent chapters are arranged to include systemic groups, *e.g.*, "Diseases of the Nervous System," "Toxic Amblyopias," etc. The references have been placed at the foot of each page, and whilst this has resulted in a small amount of duplication, it was felt that this was justified by the readiness of access thus provided.

An "Index of Authors" has been added in addition to the general Index.

My especial thanks are due to Dr. Hugh Thursfield and Dr. John Parkinson.

Dr. Thursfield has spent much time and trouble in reading the proofs through for me. I do not care to remember the omissions, inaccuracies and ambiguities which his knowledge, and skill in literary matters have revealed; all his suggestions have been adopted.

Dr. Parkinson, in the earlier stages, has made many valuable suggestions from his wide experience. These have been the means of saving me much trouble later. He has also given me no small amount of practical help.

I have to thank my colleagues at St. Bartholomew's and Moorfields for the free hand which they have given me with respect to the patients under their care. This has made possible many of the observations.

I have to thank Sir John Parsons for Fig. 77.

Mr. Humphrey Neame, Pathologist at Moorfields, has prepared some of the specimens for me, and has given much help in their reproduction. I have to thank Mr. Maurice Whiting for the specimen from which Fig. 26 is made.

Figs. 9, 18, 28, 37, 40, 48, 55 and 67 are from specimens belonging to Moorfields, and I have to thank my colleagues there for permission to use them.

For Fig. 74 I am indebted to the *British Journal of Ophthalmology ;* for Figs. 14, 59, 60, 63, 72 and 73 to *Brain ;* and to the *Journal of Anatomy and Physiology* for Figs. 1 and 2.

Lastly, I have to thank Messrs. J. and A. Churchill for the courtesy with which they have endeavoured throughout to meet my wishes.

R. FOSTER MOORE.

Harley Street.

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THE CORTICAL REPRESENTATION OF VISION.

It has long been recognised that the visual cortical area of the brain is, for the most part, situated on the inner aspect of the occipital lobe.

It is probable that the area striata of the brain, *i.e.*, that part of the cerebral cortex in which the stria of Gennari occurs, represents the true visual cortex, and Elliot Smith [1] has shown how exceedingly sharply defined is this area, and how easily this, as well as other portions of the cortex, may be delimited by macroscopic methods.

The limits of the area are thus defined by him :—

" Not only are both walls of the sulcus calcarinus (posterior calcarine fissure, Cunningham) formed entirely of area striata, but part of the lingual convolution below it is also formed of area striata " (Fig. 1, p. 2).

The dorsal boundary of the area striata in the cuneus is the sulcus cunei, which Elliot Smith has named the Sulcus Limitans Superior Area Striatæ.

The ventral boundary of the area striatæ in the lingual gyrus is the sulcus lingualis which thus becomes the Sulcus Limitans Inferior Areæ Striatæ.

[1] *Jour. Anat. and Physiol.*, 1907, xli., 200.

"If these two sulci, the sulcus cunei and the sulcus lingualis, which limit the area striata dorsally and ventrally respectively to the posterior calcarine fissure, be traced backwards, it will be found in many cases that these fissures each form a semi-circular sulcus which has been termed polar (Fig. 2, p. 3), and which may be named the Sulci Polaris Superior and

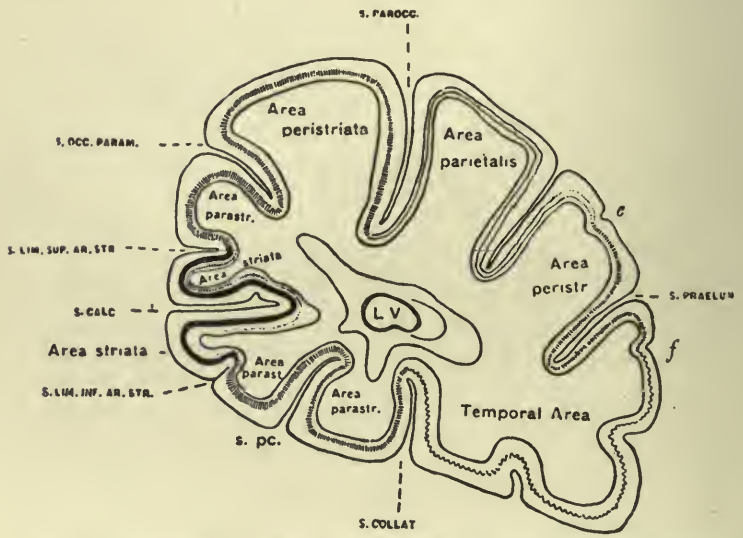


FIG. 1.—A diagram to represent the distribution of the different cortical areas in a coronal section through the left hemisphere one centimetre behind the fossa parieto-occipitalis. *LV.* = Posterior cornu of lateral ventricle. *s. calc.* = posterior calcarine sulcus. *s. lim. sup. ar. str.* = sulcus cunei (sulcus limitans superior areæ striatæ). *s. lim. inf. ar. str.* = sulcus lingualis (sulcus limitans inferior areæ striatæ). Note how the stripe of Gennari (the thick black line) ends abruptly at the bottom of the sulcus cunei and the sulcus lingualis. (After Elliot Smith.)

Inferior. The area striata extends as far as the lip of these furrows without entering into the formation of their walls; in the case of the cuneal and lingual sulci the area striata extends into the furrow and stops in its floor (Fig. 1). The area striata usually extends on to the lateral surface of the hemisphere and is folded axially to form the sulcus calcarinus externus of Cunningham, and ends at, or close to, the caudal lip of the sulcus lunatus. The area striata forms the ventral wall only

of the anterior calcarine fissure (Cunningham) and stops in the floor of the sulcus (Fig. 2). When the gyrus cunei is reached, the area striata crosses the floor of the furrow and extends exactly as far as the crest of the small gyrus."

These, then, are the topographical boundaries of that part of the cerebral cortex in which the stria of Gennari is present, to which the name area striata has been applied, and which is

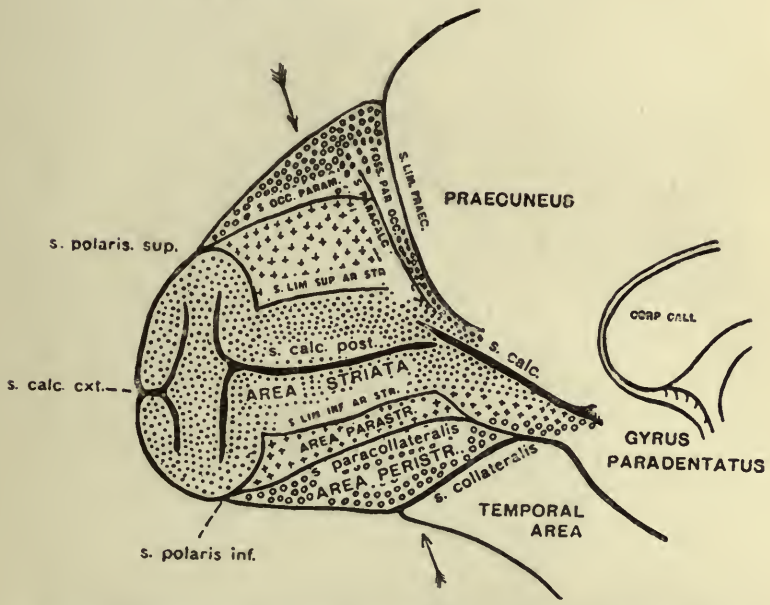


FIG. 2.—A diagram to illustrate the distribution of the cortical areas on the mesial surface of the occipital region of the left hemisphere. The two arrows indicate the plane of the section shown in figure. The area striata is represented by dots; the area parastriata by crosses; the area peristriata by circles. (After Elliot Smith.) Compare the above with Gordon Holmes' diagram (Fig. 3, p. 4), arrived at on clinical grounds, and with the cortical visual area as defined by Schäfer (p. 7), and arrived at as a result of physiological investigation.

believed to represent the part of the cortex which is concerned with vision.

From the clinical side our knowledge has been advanced and placed on a secure basis as a result of the careful and thorough work of a number of observers, especially of Gordon Holmes, and Gordon Holmes and Sir William Lister.

These investigators [1] examined thoroughly a large number of men who were wounded in the occipital region of the skull, and correlated the position of the injury to the brain with the visual fields, as taken either with a perimeter or by means of a

Fig. 3.—A diagram of the probable representation of the different portions of the visual fields in the calcarine cortex. Fig. 3 is a drawing of the mesial surface of the left occipital lobe with the lips of the calcarine fissure separated so that its walls and floor are visible. The markings of the various portions of the visual cortex which is thus exposed correspond with those shown on the chart (Fig. 4) of the right half of the field of vision. (Gordon Holmes.)

Bjerrum's screen. The site of the damage to the brain was in some cases confirmed at autopsy, in other cases it was judged either at operation, or arrived at by craniometric measurements.

[1] *Brit. Jour. of Ophth.*, 1918, 353; *Proc. Royal Soc. of Med.*, Section of Ophth., 1916, ix., 57.

A complication which gave rise to some difficulty in correlating the site of the wound, with the resulting defects of the visual fields, was the fact that a projectile which had damaged the cerebral cortex had often traversed a part of the brain, and in

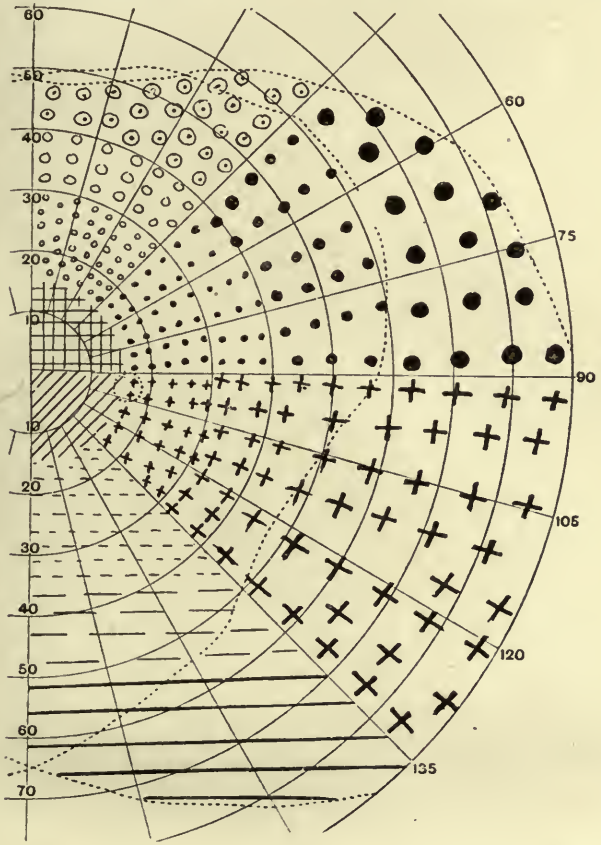


Fig. 4.

so doing had damaged the fibres of the optic radiations as well as the cortical area.

On this account it was difficult to apportion accurately, the defect which was due to damage suffered by fibres coming from the mid brain, and that which was due to cortical destruction.

Central Vision.—The part of the cortex concerned with

central vision, *i.e.*, macular representation, is at the occipital poles, extending on to the lateral surface of the brain, for a number of cases have been observed, in which damage limited to one or to both occipital poles produced respectively, an homonymous paracentral scotoma, or a central scotoma in both eyes, the peripheral fields being complete.

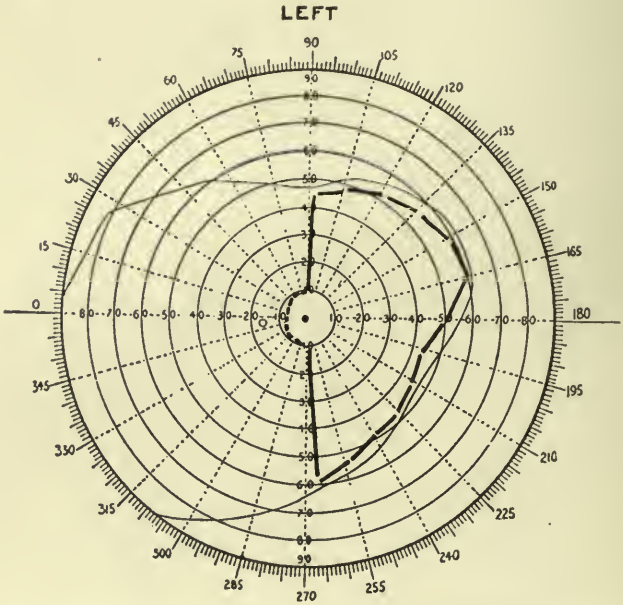


Fig. 5.

Figs. 5 and 6 are the visual fields from a man of sixty-three who had symptoms of thrombosis of the right posterior cerebral artery.

In the unilateral injuries in which an homonymous paracentral scotoma was present, this always extended right up to the fixation point, and Wilfred Harris [1] has observed, that in the temporary hemianopia which may accompany migraine, the dividing line between the seeing and blind halves also passes through the fixation point.

It has for long been recognised that in cases of homonymous hemianopia in civil practice due to obstruction of the posterior cerebral artery, whether by an embolus or as a result of throm-

[1] *Brain*, 1897, xx., 360.

bosis, the scotoma falls short of the fixation point by about 10 degrees (Fig. 5 and 6), and this has given rise to the suggestion that each macula is represented in each cerebral cortex right and left.

In view of the before-mentioned facts it is clear that this explanation can no longer be maintained, and it is suggested by Holmes and Lister that the explanation of the escape of the macula in vascular lesions is to be found in the fact, that the

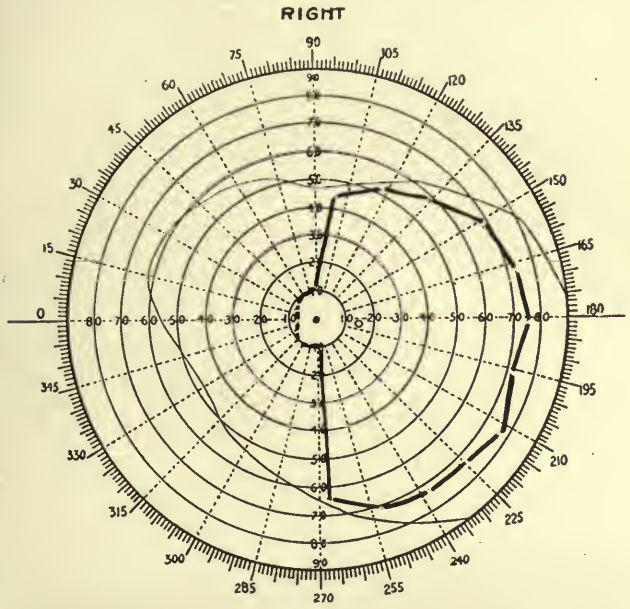


Fig. 6.

occipital pole is a borderland territory as regards the distribution of the posterior and middle cerebral arteries, and that if one of those vessels is blocked the other will supply sufficient blood for the needs of this area of the cortex.

With regard to the representation of the other parts of the retina Schäfer [1] gives them as the result of experimental work as follows:—

(1) The whole of the visual area of one hemisphere is

[1] "Text Book of Phys.," Edinburgh and London, 1900, ii., 757.

connected with the corresponding lateral half of both retinæ.

(2) The upper zone of the visual area of one hemisphere is connected with the upper zone of the corresponding lateral half of both retinæ.

(3) The lower zone of the visual area of one hemisphere is

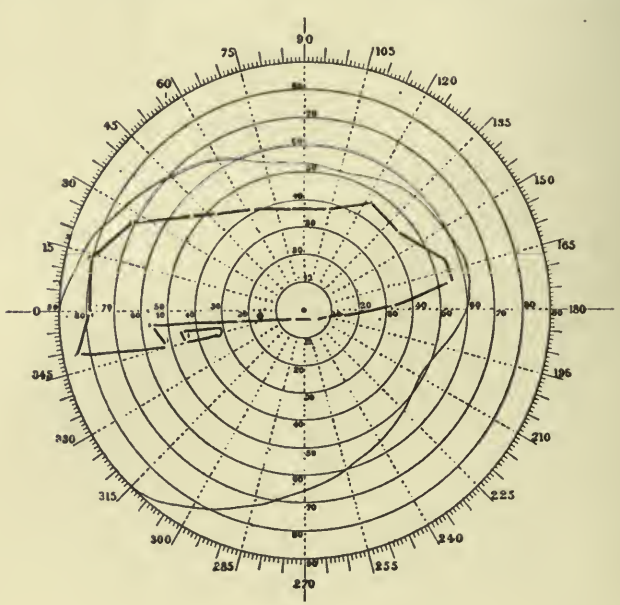


FIG. 7.

FIGS. 7 and 8 represent a nearly complete inferior hemianopia from a gun-shot injury to the occipital cortex and optic radiations. The wound of entry was 1 inch behind the left parietal eminence, the exit wound being 1½ inches to the right of the middle line and about 1½ inches above the external occipital protuberance. Central visual acuity was unimpaired. The fields were taken five years after the injury.

connected with the lower zone of the corresponding lateral half of both retinæ.

(4) The intermediate zone of the visual area is connected with the middle zone of the corresponding lateral half of both retinæ.

Holmes and Lister's results are in large measure in accord with the foregoing.

They found that wounds which involve the upper lip of the

posterior calcarine fissure produce a corresponding homonymous loss in the lower visual fields, showing that the upper parts of the retina are represented in the upper lips of the fissure.

The charts (Fig. 7 and 8) were obtained from a soldier about five years after being wounded by a rifle bullet: the entrance wound was about 1 inch behind the left parietal eminence, the exit was $1\frac{1}{2}$ inches to the right of the middle line and $1\frac{1}{2}$ inches above the external occipital protuberance; his central vision was not affected. It seemed probable that the damage on the

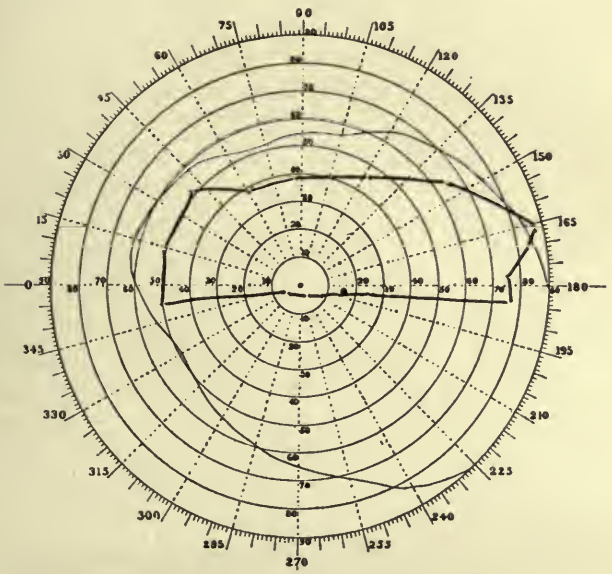


FIG. 8.

left side of the brain was chiefly to the optic radiations, and on the right side the cortex was destroyed.

It is remarked by Holmes that cases which demonstrate a loss of the upper field of vision with damage which could, with good reason, be referred to the lower lips of the calcarine fissure are much less common, yet all observations go to show that this relationship does exist.

It seems clear that the upper parts of the retina are represented in general along the upper margin of the posterior

calcarine fissure, and the lower parts along the lower lips of this fissure.

Further, lesions which had damaged the more anterior parts of this region, *i.e.*, at the apex of the cuneus, gave rise to defects at the periphery of the field of vision (Figs. 3 and 4), and suggest, therefore, that the more peripheral parts of the retina are represented far forwards.

It will be clear that few cases can occur where the cortex at the bottom of the calcarine fissure is damaged without complicating damage to surrounding cortex or optic radiations.

A case of Wilbrand and Henschen's, quoted by Holmes, in which a narrow homonymous scotoma extended from the fixation point horizontally outwards to 60 degrees, and in which it was found that softening of the brain was present at the bottom of the calcarine fissure, suggests that the horizontal parts of the retina are represented along the deeper parts of the area striata, and Holmes states that he has seen many cases where superficial injuries of the mesial aspect of one hemisphere were associated with blindness along the vertical meridians of the visual fields.

Lesions of the Optic Radiations.—I have seen a man in whom a shrapnel ball had entered over the left ear and had come to rest on the tentorium cerebelli of the left side. It seemed that it must have been the lower fibres of the radiations which were damaged and that injury to the cortex could be excluded; he had a sharp cut right superior quadrantic hemianopia.

Holmes has seen cases where it was judged that the damage involved the more dorsal fibres of the radiations, and which were associated with inferior quadrantic hemianopia. He states "it seems tempting to assume, that even in the main mass of the radiations, those indirectly connected with the upper and lower halves of the retina are contained in distinct bundles separated from each other by an anatomical interval, but this hypothesis seems *à priori* so improbable, that it cannot be accepted without further evidence, and unless an anatomical basis for it can be found."

The Nature of the Brain Lesions.—In many cases of gun-shot wound of the brain it will be found that in the early days after

the injury marked recovery of vision occurs, and according to Hine [1] the recovery starts with central vision and extends peripheralwards from here, but in other cases the reverse sequence is seen.

It would seem that in these cases the temporary visual loss is due to concussion in the surrounding brain, and that there is no constant rule as to whether recovery takes place from the periphery towards the macula or *vice versâ*.

The sequence of recovery probably depends entirely upon the position of the damage done, and takes place from the less damaged towards the more damaged area, until the limit of those parts which are permanently destroyed is reached, where no recovery can occur and a corresponding permanent defect remains. In cases which were examined three weeks or more after the receipt of the injury the edges of the scotoma were usually quite sharp and did not change afterwards.

Riddoch [2] believes that in an area of the visual field in which recovery is taking place, light and movement are the first stimuli to be appreciated, and that consequently the investigation of the field for movement is of considerable prognostic importance.

Losses of the visual fields for colour have frequently occurred, but never, in Holmes' experience, apart from constriction of the fields for white; he has seen no case in which there was a perfectly intact field for white but loss of the fields for colours.

Subjective Visual Phenomena.—It is not uncommon for subjective visual phenomena to occur during the first few weeks after the receipt of an injury to the visual cortex, but they are much less common in the later periods.

These phenomena at times take the form of coloured lights and flashes, thus suggesting that colour perception is resident in the calcarine region of the cortex.

The following are Gordon Holmes' conclusions (Figs. 3 and 4):—

(1) The upper half of each retina is represented in the dorsal, and the lower in the ventral, part of each visual area.

[1] *Brit. Jour. of Ophth.*, 1918, ii., 12.
[2] *Brain*, 1917, xl., 15.

(2) The centre for macular or central vision lies in the most posterior part of the visual cortex, probably on the margins and on the lateral surfaces of the occipital poles. The macula has not a bilateral representation.

(3) The centre for vision subserved by the periphery of the retina is situated in the anterior portions of the visual areas, and the serial concentric zones of the retina from the macula to the periphery, are probably represented in this order from behind forwards in the visual cortex.

(4) Those portions of the retina adjoining the vertical axes are probably represented in the dorsal and ventral margins of the visual areas, whilst the retina in the neighbourhood of its horizontal axis is projected on the walls and the floor of the calcarine fissures.

(5) Given lesions of the visual cortex produce complete blindness in the corresponding portions of the visual fields, or if incomplete an amblyopia, colour vision being generally lost and white objects being indistinct, or only more potent stimuli as abruptly moving objects, may excite sensations.

(6) The defects of vision in the fields of the two eyes are always congruous and superimposable, provided that no abnormality of the peripheral visual apparatus exists.

(7) Lesions of the lateral surfaces of the hemispheres, particularly of the posterior parietal regions, may cause certain disturbances of the higher visual perceptual functions with intact visual sensibility, as loss of visual orientation and localisation in space, disturbance of the perception of depth and distance, visual attention loss, and visual agnosia.

PAPILLŒDEMA.

This term, first introduced by Parsons to indicate the pathology of the condition, has, in large measure, replaced such terms as optic neuritis, papillitis, choked disc, etc.; and there seems no doubt that in the most important group of cases, where the disc changes are an indication of increased intra-cranial pressure,

they are due to an œdema of the nerve head which has a physical basis.

Pathology.—The pathology of the condition has been worked out with especial care by Parsons, and Paton and Gordon Holmes.[1]

They show that the swelling of the disc is due almost entirely to infiltration with fluid of its tissues and the anterior layers of the lamina cribrosa. As the disc swells it displaces the retina

Fig. 9.—A longitudinal section through the optic disc in a case of papill-œdema, showing its prominence due to œdematous swelling.

laterally (Fig. 9), often throwing it up into small folds, which may be seen with the ophthalmoscope as faint lines concentric with the disc margin. As the swelling increases the even course of the nerve fibres becomes disturbed, and some of the more peripheral ones take on a somewhat acute S-shaped curve. The axial fibres become raised to fill up the physiological cup, which is further filled in by the collection of œdema fluid under the internal limiting membrane.

The alterations in the other layers of the retina are surpris-

[1] *Brain*, 1911, xxxiii., 389.

ingly slight, and are limited to a little œdema in the immediate proximity of the disc.

Changes in the Vessels.—There is well-marked distension of the veins and capillaries, and hæmorrhages on the disc and in its immediate vicinity are usually present in a case of any severity.

Inflammation.—With regard to the presence of histological evidence of inflammation, Paton and Holmes found slight small-celled infiltration into the connective tissue sheath of some of the vessels in cases where papillœdema had been intense, it was, however, so infrequent, so scanty, and involved so few of the vessels—most of them being quite free—that they attribute it to a reaction of the tissues to degenerative and destructive processes which are going on in the nerve.

They state further, that the histological characters of papill-œdema, no matter at what stage of its development they may be examined, are not those of an inflammatory process, and that in two cases in which papillœdema occurred in septic menin-gitis, in which the meningeal inflammation extended to the optic sheath, there was as little evidence of inflammatory changes in the papilla as in cases due to cerebral tumour.

When the condition has been in progress for some time, degenerative processes occur which are manifested by the nerve fibres becoming irregularly swollen and varicose, and later breaking up into degenerative masses with nucleus-like centres—the so-called cytoid bodies. These in course of time undergo lipoid degeneration, as shown by Parsons, and ulti-mately disappear; the ganglion cells become shrunken and diminished in number.

Sclerotic Changes.—As the papillœdema subsides, if secondary atrophy results, conspicuous histological changes coincidentally appear. The disc shrinks, there is a diminution of the nerve fibres, a proliferation of the neuroglial nuclei and fibres, and an increase of the fibrous tissue which surrounds the vessels.

In a case in which, as a result of a decompression operation, subsidence of the papillœdema occurs without consecutive atrophy, there is very little, if any, neuroglial increase.

Relation of the Ophthalmoscopic Appearances to the Histo-

logical Changes.—The blurring and obscuration of the disc edges is partly due to the increased depth of the tissues forming the nerve head, and partly to the dispersal of light by the interspersed fluid (Fig. 9).

The greyish-white striation of the disc and adjoining retina is due to the separation of the nerve fibres by œdema.

Hæmorrhages are either flame-shaped, if in the nerve fibre layer, more solid and homogeneous if between the internal limiting membrane and the nerve fibres, or more or less circular if in the deeper parts of the retina.

The soft-edged white patches near the disc are produced by the swelling of the nerve fibres and the products of their degeneration, varicose nerve fibres and cytoid bodies.

The opaque white appearance of the atrophic disc is produced by the occlusion of the smaller vessels and the glial sclerosis, the white lines along the veins on the disc are due to thickening of their walls, and the diminution in the size of the arteries is due to their compression in the sclerosed tissues.

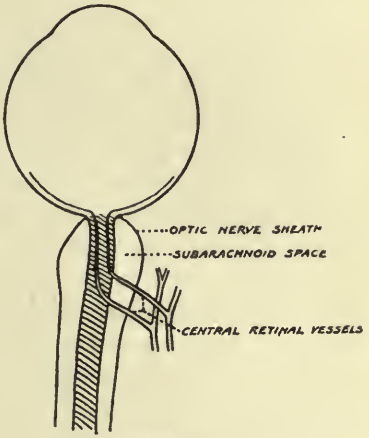


Fig. 10.

Pathogenesis of Papillœdema.—It has been shown, that from a histological point of view, the changes in the nerve head are those of a simple œdema, and the most complete and satisfactory explanation of its mode of production is that of a physically produced œdema, due to obstruction to the outflow of blood and lymph from the eye.

Let it be borne in mind that the subarachnoid space of the vaginal sheath of the optic nerve is in free and direct communication with the cerebral subarachnoid space (*vide* p. 47), so that any increase in the intra-cranial pressure is transmitted directly to this space.

If now the central retinal vessels be traced backwards from the retina, they lie at first in the substance of the optic nerve, but about 12 mm. behind the globe they leave the nerve and traverse this subarachnoid space in order to pierce the dura, and so reach their parent trunks in the orbit (Fig. 10).

As they traverse the space, artery, vein, and lymphatics will be subject to any increase of pressure that may exist, but whereas the artery contains blood at a pressure which is estimated at 100 mm. Hg. by Leonard Hill, or 80 to 100 by Duverger and Barrè,[1] the fluid in the vein and lymphatics is at a much lower pressure, consequently the inflow of blood to the eye will be but little affected, but the outflow of blood and of lymph from the nerve head into the sheath space will be obstructed; there will be as a consequence increased transudation of lymph, with œdema of the nerve head.

This method of production of papillœdema supposes no interference with the choroidal circulation, and no changes in this membrane are found.

Confirmation of this theory is supplied by the fact, that in the case of a tumour which presses directly on the nerve at the optic foramen, the subarachnoid space of the nerve is shut off from the cerebral subarachnoid space, and so the retinal vessels as they traverse this space, are protected against any increase of intra-cranial pressure that may occur.

In such a case, then, papillœdema should not develop.

This is exemplified in pituitary tumours, which most often produce a primary optic atrophy from pressure upon the nerve, and sometimes a frontal tumour may press directly upon one optic nerve, producing primary atrophy in it, whilst papillœdema is developed in the other eye, its subarachnoid space remaining in free communication with the subarachnoid space of the brain, and so its retinal vessels are not protected against the increased intra-cranial pressure.

It may, however, be remembered, that pressure on the nerve at the optic foramen which is sufficient to produce optic atrophy will probably also obstruct the ophthalmic artery, and so will diminish the inflow in the retinal artery.

[1] *Arch. d'Ophth.*, 1920, xxxvi., 71.

Papillœdema and other Disc Changes.—Papillœdema is seen in its most characteristic form in cases of cerebral tumour, in some cases of intra-cranial abscess, meningitis, and renal disease.

There are, besides, a number of conditions, such as retro-bulbar neuritis, disseminate sclerosis, some cases of meningitis, arterio-sclerosis, etc., in which changes occur in the disc which are limited to haziness of its edge, slight swelling and a few hæmorrhages, but without, as a rule, any high degree of œdema or swelling.

These changes are, as a rule, included under the term papill-œdema, although they differ in appearance and in clinical significance from those which occur in their typical form in cases of cerebral neoplasm. Thus, at the present time, the mild ophthalmoscopic changes which may occur, for example, in the nerve head from the presence of a focus of degeneration close behind the globe in a case of disseminate sclerosis, are not differentiated by name from the high degree of swelling and œdema of the disc which results from the presence of a cerebral tumour, and which is probably due immediately to a heightened intra-cranial pressure.

Some German writers, such as Uhthoff, do, however, draw a rather artificial distinction, in that those cases in which swelling is less than 2 D. are called optic neuritis, whilst those with more than this degree of swelling are termed choked disc.

Ophthalmoscopic Appearances.—Without describing the changes as they are seen with the ophthalmoscope, it may be said that the haziness of the disc margins most often begins in the upper nasal quadrant, that the appearance of the disc may remain unchanged for a long period—many months or even a year if a palliative operation is not performed—and that at times small hæmorrhages on the disc may precede any other sign of papillœdema by as long as several weeks. In some cases, especially in children, a series of fine, white dots is developed in lines radiating from the yellow spot, simulating the condition often seen in renal retinitis; they differ, however, from the renal changes in that the dots are finer, and are usually limited to the side of the yellow spot towards the optic

disc, *i.e.*, they form a fan-shaped figure between the disc and macula, rather than a star-shaped figure which surrounds the macula.

Incidence.—Uhthoff [1] gives the following table of the causes of papillœdema :—

	Per cent.
Brain tumour	71
Brain tuberculoma	3·6
Cerebral syphilis	12
Oxycephaly	2·2
Brain abscess	2·2
Tuberculous meningitis	1·1
Nephritis	1·1
Lead poisoning	0·3

Amongst 200 cases of cerebral tumour, Paton found forty which showed no signs of papillœdema when traced either to their death or to cure by operation.

He showed that the incidence varies greatly with the site of the tumour.

Thus in tumours limited to the subcortical region or to the pons, papillœdema occurs in about one-half of the cases only, and when it occurs it seems to imply that the subcortical tumour has invaded the basal nuclei, or the pontine tumour has invaded the cerebellum.

On the other hand, all cerebellar, fourth ventricle and temporo-sphenoidal tumours are associated with papillœdema.

Gowers, speaking of tumours arising in the meninges, states that those which infiltrate the tissues, and those which develop at the base of the brain, are more apt to produce papillœdema than those which arise on the convexity, and which displace the tissues only.

The relative immunity from papillœdema in tumours of the cortical area and its severity in tumours of the cerebellum was brought out by Lawford and Edmunds in their analysis of 107 fatal cases.[2]

[1] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1914, xxxiv, 51.
[2] *Trans. Ophth. Soc. U.K.*, 1884, iv., 172, and v., 184.

Papillœdema is of exceedingly rare occurrence in cases of cerebral or intra-cranial hæmorrhage or cerebral softening.

Amongst sixty-eight patients whom I examined, who were diagnosed by the physician as suffering either from cerebral hæmorrhage or softening, I did not find a case of papillœdema.

Hughlings Jackson[1] says: "Optic neuritis is exceedingly rare in cases of extensive destruction of brain by softening or clot. I now doubt whether I have ever seen double optic neuritis from clot, although I have seen the two things coincident."

Bristowe,[2] however, reports a case in which the opthalmoscopic appearances were confirmed by Nettleship, and in which a post-mortem examination was made by Sharkey. The hæmorrhage was a large one, involving parts of the optic thalamus, internal capsule, lenticular nucleus and the white matter of the temporo-sphenoidal lobe. The brain tissue forming the walls of the cavity was examined histologically by Sharkey, lest it should be a tumour into which hæmorrhage had occurred, but no growth was found. The man had lived for forty-six days after the onset of the hæmorrhage.

In cases of cerebral syphilis with papillœdema, in 65 per cent. according to Uhthoff, there is a gummatous syphilitic tumour of the brain or its meninges, and in 23 per cent. a gummatous basal meningitis.

Recurrence.—It is rare for papillœdema to recur after once it has subsided, even though atrophy has not resulted.

Taylor[3] reports cases of recurrence of tumours without recurrence of papillœdema.

A case is reported, however, by de Schwenitz and Thomson[4] in which papillœdema subsided after a palliative trephining, and a typical post-neuritic atrophy resulted. Thirteen months later papillœdema recurred with 5 D. of swelling.

As showing for how long a time a cerebral tumour which ultimately causes papillœdema may be present before this occurs, Hughlings Jackson[5] reports the case of a man who had

[1] *Trans. Ophth. Soc. U.K.*, 1881, i., 63.
[2] *Trans. Ophth. Soc. U.K.*, 1886, vi., 363.
[3] *Trans. Ophth. Soc. U.K.*, 1894, xiv., 111.
[4] *Archiv. of Ophth.*, 1895, xxiv., 252.
[5] *Trans. Ophth. Soc. U.K.*, 1881, i., 80.

had symptoms of tumour for nine years, the existence of which was confirmed post-mortem, but who developed papillœdema one month only before he died.

Homolaterality.—Much variation of opinion has been expressed by different observers, as to whether a papillœdema of earlier development or greater degree on one side implies that a tumour is on the corresponding side of the brain.

There are difficulties in this matter. In the first place, papillœdema commences, as a rule, so nearly contemporaneously in each eye, that what small difference there is in this respect would seldom be felt to have much weight.

Again, it is not easy in most cases, when the papillœdema is well developed, to say upon which side it is the more advanced, and measurements of the degree of swelling must be made with meticulous care and with a number of precautions, if they are to be any real guide in the matter.[1]

It is only, I believe, by making a diagram of the disc and vessels, and making a note of the particular spots on the vessels which are used, and taking these same spots at the next examination, that observations of any value can be arrived at, and it is seldom that a difference of any weight can be estimated.

I have known observers to provide measurements of the degree of swelling of the disc when in fact they were, unknowingly, only estimating the patient's astigmatism. Victor Horsley, Gowers, and Gordon Holmes[2] believed that the tumour was most often on the side of the brain on which the earlier or the most intense papillœdema was present; Paton and Farquhar Buzzard, on the other hand, believe in general that no such relationship exists. Uhthoff says: "I think too much importance is attached by some surgeons to the significance of homolaterality of the lesion as a symptom."

Mohr[3] found that in 56 per cent. of cases of tumour, papillœdema was ipso-lateral, and in 44 per cent. it was contra-lateral.

There is no doubt that in very many cases it is not possible to state on which side the papillœdema is the further advanced;

[1] I have never been able to estimate a greater degree of swelling of the disc than 5·0 dioptres, and so high a degree as this is very exceptional.

[2] *Trans. Ophth. Soc. U.K.*, 1908, xxviii., 134.

[3] *Klin. Monats. f. Aug.*, 1912, xiv., 401.

there is a class of case, however, in which a tumour produces optic atrophy from direct pressure on the optic nerve of one side, and papillœdema in the other eye from the increased intracranial pressure. In such a case it is clear that the tumour is on the side of the optic atrophy.

Cerebral Abscess.—There is much difference of opinion as to the frequency of papillœdema in cases of cerebral abscess, and no doubt much depends upon the stage at which it is seen.

Gowers [1] believes that it will be found in about 75 per cent. of cases where there is reason to believe that the abscess has existed for four weeks or longer.

There seems to be a consensus of view, that the existence of unilateral disc changes, or of a greater degree of change on one side than on the other, does in the case of abscess, imply with much likelihood that the abscess is on that same side of the brain.

Thus Uhthoff [2] says that in 13 per cent. of cases of cerebral abscess with papillœdema, the papillœdema was unilateral, and that in four-fifths of these it was on the same side as the abscess, and further, that where it was bilateral, the greater prominence was on the side of the abscess in four-fifths of the cases, a view which is similar to that held by Gowers.

The Value of Cerebral Decompression Operations for the Preservation of Sight.—It is well recognised that a high degree of papillœdema may be present without the visual acuity or the visual fields being impaired, and that the process may run its course to complete subsidence and leave the visual functions intact.

On the other hand, most cases of papillœdema are followed by a varying degree of atrophy of the nerve, and greater or less impairment of sight, so that if it can be shown that a palliative decompression operation will lessen the likelihood of ensuing blindness, even though no other advantage were obtained, its performance is clearly justified.

Of the benefit to be obtained in this respect, however, there can be no doubt.

[1] "Medical Ophthalmoscopy," 1904, 147.
[2] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., 65.

The general view is that the earlier the operation is performed the better is the prospect, and that in the presence of a cerebral tumour, trephining should be done on the first symptom of visual defect, such as attacks of temporary blindness, even though papillœdema is absent. The ultimate condition of the sight in unoperated cases is analysed by Uhthoff.[1] He finds that in 15 per cent. of cases the sight remained nearly normal for periods up to six years, and in another 28 per cent. diminished sight remained stationary for periods up to five years; in 38 per cent. there was great loss of sight up to blindness; 19 per cent. were untraced. He points out that in those cases in which the papillœdema remains apparently unchanged for long periods, *e.g.*, a year or more, if deterioration of sight then sets in, its progress is usually rapid and complete.

In those cases in which operation was performed late, when atrophic changes were clearly present, 50 per cent. went blind in spite of trephining.

In cases in which operation is done early, de Schweinitz and Holloway [2] show how good are the results, for in an analysis of 212 operations they find that vision was preserved in 76·5 per cent.

v. Hippel,[3] as a result of the study of 272 cases, says it can be concluded with certainty, that choked disc will disappear after operation in the course of some weeks, and that as a rule vision continues to be good if it was satisfactory before, but that it does not recover if it was greatly deteriorated.

Contraction of the field is an unfavourable sign. He urges that operation should be done early, for cases in which retention of vision occurs without operation are not of sufficient frequency to justify delay.

He advises that the operation be done in two stages, the first consisting of removal of bone, and the second of incision of the dura.

De Schweinitz advises against trephining for syphilitic lesions unless a six or eight weeks' course of medicinal treat-

[1] *Trans. Ophth. Soc. U.K.*, Bowman Lecture, 1914, xxxiv., 84.
[2] *Annals of Ophth.*, 1911, xx., 272.
[3] "Cerebral Decompression in Choked Disc," Leipsic, 1909.

ment has failed; he also considers it inadvisable to trephine for the papillœdema of renal disease.

It seems abundantly clear, that a decompression operation is advisable in cases of cerebral tumour associated with papillœdema if only for the preservation of sight, and that the earlier the operation is performed, the better is the prospect of a good and permanent result.

Lumbar Puncture.—There is some evidence to show that lumbar puncture may result in a reduction of the swelling of the disc in cases of cerebral tumour, though this procedure is not without definite immediate risks to life, and fresh retinal hæmorrhages may be produced by it.[1]

Uniocular Papillœdema.—In a few cases papillœdema runs its course to complete subsidence in one eye, the other remaining normal throughout, and it seems difficult in such a case to avoid the conclusion that it is dependent upon disease either in the optic nerve itself or in the orbit in proximity to the nerve.

NYSTAGMUS.

Nystagmus occurs under many widely differing conditions and obtrudes itself to the notice of workers in several branches of medicine and surgery. It is familiar to the physician, the neurologist, the aurist and the ophthalmic surgeon.

Certain more or less rhythmic movements of the eyes occur which closely simulate nystagmus and may be termed "nystagmoid;" they have not the significance of true nystagmus and may at once be disposed of. They are sometimes referred to as pseudo-nystagmus.

Pseudo-Nystagmus is seen when, the eyes having been carried almost to the extreme limit of their movement in some direction, a sustained straining effort to increase the movement in the same direction is made. The result is a succession of jerky movements continuing the direction of the original movement, and returning again to, but not beyond, the point from which the additional movement was started.

Selbourne Bailey[2] showed that of 500 normal individuals

[1] Spiller and de Schweinitz, *Jour. of Nervous and Mental Dis.*, 1917, xlvi., 10.

[2] Quoted by Scott, *Trans. Roy. Soc. Med.*, Sect. of Neurol. Ophth. Otol., 1913, vii., xl.

20 per cent. showed nystagmus of this type when the visual axes deviated beyond the range of binocular vision.

True Nystagmus.

The movements may be horizontal, vertical, rotatory or mixed, but in rare instances other movements than these occur.

Thompson and Spicer state that in infants with spasmus nutans, the eyes occasionally undergo a rhythmic alternate divergence and convergence; Maddox [1] exhibited a case of see-saw nystagmus, one eye moving vertically upwards whilst the other moved downwards; the patient suffered from bitemporal hemianopia.

From his investigations of the eye movements in the rhythmic nystagmus which follows rapid spinning in a chair, Adolphe Abrahams [2] showed by means of cinematography, that the movements were at the rate of four a second, and that the rate of the rapid movement is to the return movement as three is to five.

Snell estimated the movements in miner's nystagmus as from 60 to 100 per minute, and Dransart at from 80 to 140.

Wilfred Harris [3] reports a unilateral case in which the movements averaged 300 a minute, and in cases of voluntary nystagmus the movements are so rapid that their rapidity can hardly be estimated.

Of the common varying movements which occur, the horizontal is by a long way the most common. Spicer [4] analysed 200 cases and found the following proportions:—

	Per cent.
Horizontal	50
Rotatory	15
Vertical	12
Mixed	4
Irregular	2
Circumduetory	2
Disjunctive	1

[1] *Pro. Roy. Soc. Med.*, Sect. of Neurol. Ophth. Otol., 1913, vii., xii.
[2] *Pro. Roy. Soc. Med.*, Sect. of Neurol. Ophth. Otol., 1913, vii., lxvii.
[3] *Pro. Roy. Soc. Med.*, Sect. of Neurol. Ophth. Otol, 1913, vii., i.
[4] *Pro. Roy. Soc. Med.*, Sect. of Neurol. Ophth. Otol., 1913, vii., xxi.

Unilaterality.—In a few cases the movements may be limited to one eye, or they may be present only when one eye is covered.

In some cases of apparent unilateral nystagmus it will be found on minute examination that the other eye is not really quite steady, but that very fine movements are present which are detected by ophthalmoscopic examination.

Duane [1] collected 52 published cases of unilateral nystagmus, and of these

34 were vertical,
11 were horizontal,
5 were rotatory,
2 were mixed.

It will be noticed that here the vertical movements are more common than the horizontal. As features of these cases he mentions :—

(1) Apparent oscillation of objects looked at.
(2) Oscillatory diplopia.
(3) The patient can himself see the movements of the eye in a mirror.

Heimann [2] divides unilateral cases into those—

(1) Occurring in highly amblyopic and misdirected eyes.
(2) Occurring in the course of severe nervous disease.
(3) Of a transitory nature accompanying or following spasmus nutans.

Neustätter [3] showed that the movements will often occur in the other eye if the first one is covered.

Symptoms of Nystagmus.—In spite of the rapid eye movements, objects do not in most cases appear to the patient to be moving, but in miner's nystagmus, and nystagmus of labyrinthine origin, such apparent movement does occur and gives rise to great confusion.

Most patients cannot see the movement of their eyes in a mirror. Some say they can at times feel the movements.

It has been pointed out by Soelberg-Wells and Duane that

[1] *Trans. Amer. Ophth. Soc.*, 1906., xi., 63.
[2] *Klin. Monats. f. Augenheilk.*, 1902, ii., 99.
[3] *Archives of Ophth.*, 1907, xxx., 158.

some patients with horizontal nystagmus read more comfortably and with less confusion if the book be held on one side, so that the lines of print run vertically. I have seen a medical man whose only eye was highly astigmatic make use of the same manœuvre.

Vertigo of ocular origin is marked in miner's nystagmus.

Visual Acuity.—Nystagmus itself does not necessarily produce poor sight, the acuity may be normal. I have known a man carry on the work of a banker's clerk, entailing the constant addition of columns of figures, without serious trouble.

In many, however, the sight is very defective, either from the lesion which has produced the nystagmus, or from associated defects such as albinism or high refractive errors.

Variations.—Apart from the variations produced according to the position of the eyes, by covering one eye, by fixing the head in spasmus nutans, or other obvious reasons, spontaneous alterations of amplitude of the movements occur for which no cause can be found.

Fawcett and Ormond report a case [1] in which the movements were sometimes vertical and at others horizontal.

The Causes of Nystagmus.—These may be conveniently classed under the following heads :—

(A) Hereditary nystagmus.
(B) Voluntary nystagmus.
(C) Nystagmus resulting from marked bilateral visual defect originating very early in life.
(D) Occupational nystagmus.
(E) Nystagmus as a manifestation of general nervous disease.
(F) Labyrinthine nystagmus.

(A) *Hereditary nystagmus.*—This heading will comprise those cases which date from birth and have an hereditary tendency ; several members of the family may be affected.

Here would be included cases of albinism which cannot be missed, but, in addition, there would be included those cases of partial albinism which in the individual may easily be

[1] *Pro. Roy. Soc. Med.*, Sect. of Neurol. Ophth. Otol., 1913, vii., xvi.

overlooked, the cause of which, however, becomes plain on the discovery of clear cases of albinism in the same family.

The supposition that albinism may involve a part of the eye, *e.g.*, the retinal epithelium at the macula—and may so be responsible for nystagmus, although all other certain signs of albinism in the individual are missing—was first advanced by Nettleship.[1]

He says [2]: "The hypothesis is, that the imperfect sight, and with it the nystagmus, is caused by deficiency of pigment in the retinal epithelium; that this want may vary in degree, and may even, perhaps, affect only a part—say the central region—of the fundus; and, lastly, that such relative or absolute lack of pigment in the epithelium is not recognisable with any certainty by ophthalmoscopic examination, the different depths of tint at the fundus depending far more upon differences of pigmentation of the choroid, than of the hexagonal epithelium."

Nettleship points out that in some pedigrees of hereditary nystagmus both sexes are affected, descent being through the unaffected mother; further, that in some pedigrees, oscillatory head movements are associated with the nystagmus, whilst in others there is no such association.

(B) *Voluntary nystagmus.*—A few individuals can produce nystagmus at will.

I have seen a medical man who could do this in a very striking manner—he discovered it by chance when a boy; the movements were almost inconceivably rapid, a fact which has been noted in other reported cases, and the term "shuddering of the eyes" describes rather well the effect produced.

Von Graefe believed that it was only those who had at one time suffered from involuntary nystagmus that could reproduce it in this way, but the instance referred to above refutes the contention.

Williams [3] reports the case of a man of forty-five who could give his eyes "an almost inconceivably rapid oscillatory movement in any direction at pleasure."

[1] *Roy. London Ophth. Hospital Reports*, 1902, xv., 110.
[2] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1909, xxix., 125.
[3] *Roy. London Oph. Hosp. Reports*, 1866, v., 223.

(C) *Marked amblyopia due to bilateral ocular defects in very early life.*—The most common causes of such amblyopia are dense corneal opacities, especially those caused by ophthalmia neonatorum, and congenital cataract.

Of 1,000 children with nystagmus due to corneal nebulæ, Bishop Harman [1] found that the nebulæ in 85 per cent. were due to ophthalmia neonatorum, and of ninety children blinded by this disease, every one showed nystagmus.

He also states that 50 per cent. of cases of posterior uveitis develop nystagmus, and that nystagmus only appears in interstitial keratitis when posterior uveitis also exists.

It is probable that there is a limited period during the first few months of life, during which complete co-ordination of eye movements can be acquired, and if, during this time, such co-ordination is not developed, owing to enforced closure of the eyes from ophthalmia neonatorum or some similar disease, then it is never properly developed at all.

Thus one may see children with nystagmus as a legacy from an attack of ophthalmia neonatorum, in whom the ocular media are all but perfectly clear.

The mode of development of this type of nystagmus is thus given by Spicer [2]:—

"When a child is born the eyes move independently and wander about till something, such as a light, attracts the vision, the image approaches the fovea and becomes more defined, and when it reaches the fovea becomes sharply defined and clear to the normal eye; the muscles and visual centres quickly co-ordinate themselves, so that without any conscious effort the child can bring the image of the object on the fovea at once.

"Further, all the movements of the eyes become co-ordinated, although, to do this, many muscles whose actions are not the same in the two eyes, are brought into simultaneous use.

"The proper action of the co-ordinating centre of muscular action requires the stimulus of exact retinal images; without proper retinal stimulation fixation is imperfect.

"Among the actual causes which produce imperfect images,

[1] *Pro. Roy. Soc. Med.*, Sect. Neurol. Ophth. Otol., 1913, vii., lvi.
[2] *Pro. Roy. Soc. Med.*, Sect. Neurol. Ophth. Otol., 1913, vii., xxiv.

the most frequent are the consequences of ophthalmia neonatorum, anterior synechia, pyramidal cataract, and congenital cataract.

"The failure of use of the eyes in the early days of life itself leads to imperfection in the development of the visual centre, and, consequently, of the co-ordinating centres of the muscles moving the eyes.

"These children remain amblyopic and have oscillating eyes.

"That this want of development of the visual and co-ordinating centres is due to a want of use during the early stages of life, is shown by the fact that leukomata and cataract acquired in after-life do not lead to amblyopia or nystagmus."

(D) *Occupational nystagmus.*—This term comes tc be almost synonymous with miner's nystagmus, for, although nystagmus may develop in those engaged in a few other occupations, as pointed out by Snell, it is exceedingly infrequent and of less importance.

The special features of this form of nystagmus are the very marked subjective symptoms which accompany it; thus Llewellyn [1] remarks that nystagmus in general is conspicuous as a physical sign rather than for its subjective symptoms, whereas in miner's nystagmus it is the symptoms that are distressing and disabling.

Figures as to incidence are of little value, for there are characters, local to particular types of mines, which are very largely responsible for its occurrence or its absence.

Llewellyn states that during 1912 one man in every 2,700 employed underground received compensation.

Causation.—Certain facts as to its causation are clear, but with regard to others there remains considerable divergence of views amongst those who have made a particular study of the condition, even where what would seem discrete facts are concerned.

There seems to be a complete consensus of view, that in mines where it is possible to use naked lights instead of the Davy lamps the condition is almost unknown, and Llewellyn has

[1] *Pro. Roy. Soc. Med.*, Sect. Neurol. Ophth. Otol., 1913, vii., xliii.

pointed out how exceedingly feeble is the illumination obtained from a Davy lamp, and how little of its light reaches the eye, having regard to the dead black surroundings which absorb most of the light.

Now it is the higher visual acuity obtained at the fovea which is mainly responsible for fixation; with dark adaptation, however, the acuity at the fovea becomes *less than* that of the rest of the retina, which is uniform all over.

It is easy to satisfy oneself with regard to this point by looking at a star of low intensity on a dark night.

It is seen much more distinctly if the line of vision is directed to one side of it, so as to bring its image on some part of the retina away from the fovea instead of directly on this spot.

Owing, then, to the absence of a spot of hyperacute vision, fixation becomes difficult, the eyes are loosed from the control of central vision, and wandering movements easily arise.

Nieden [1] and Snell agree in looking upon the forced use and over-fatigue of the elevator muscles of the eyes as one of the most important causes.

They state that it chiefly occurs in men engaged in "holing," *i.e.*, in obtaining coal by undercutting masses; this entails a lying position, the eyes being directed upward and obliquely all the time; the miner is continuously moving his eyes right and left, but always upwards, till the hole is completed, and this puts a very great strain on the elevator muscles; a view which is also shared by Lafon.[2]

Reid,[3] however, shows that it may occur in pits where men do not lie down, and where no holing is done.

He looks upon the following as important factors:—

(1) Conditions tending to do away with yellow spot fixation, *i.e.*, feeble illumination.
(2) Conditions tending to disturb the equilibrium of the body.
(3) Conditions in which a series of rhythmic movements is

[1] "Miner's Nystagmus," Bergmann, Wiesbaden.
[2] *Annales d'Oculistique*, 1920, clvii., 529.
[3] *Brain*, 1906, xxix, 367.

made by the body, the eyes remaining fixed on the object.

(4) Debilitating influences, alcoholism, influenza, accidents, etc.

Llewellyn considers the presence of refractive errors an important contributory cause, whilst Nieden thinks refractive errors have but little influence.

Llewellyn states that of 887 men with nystagmus examined by him, a much larger proportion than of normal miners had fair hair.

The Movements.—The movements are rotatory or lateral in most cases; they are increased on looking upwards, and decreased or even abolished by looking down, and as a consequence of this the men will often walk about with the head thrown back, their eyes being thus brought into the most stable position.

Diplopia is a not uncommon symptom, and in most cases is crossed, and so due to defects of convergence; thus, of seventy-one cases, Dransart [1] found crossed diplopia in sixty-nine and homonymous diplopia in two; and Ohm,[2] amongst 195 cases, found crossed diplopia in 188 cases and homonymous in seven only.

(E) There are several diseases of the nervous system in which nystagmus frequently occurs, such are disseminate sclerosis, syringomyelia, and Friedreich's ataxia; these are referred to under their individual heads.

Lesions of the cerebellum, whatever their nature, whether inflammatory or neoplasms, are very frequently associated with nystagmus.

Uhthoff [3] found that nystagmus occurred in 17 per cent. of intra-cranial tumours, and that 75 per cent. of these were situated in the posterior cranial fossa; and Taylor states that lesions of the cerebral hemispheres do not give rise to nystagmus.

Risien Russell (quoted by Taylor) has shown that, after removal of one-half of the cerebellum in animals, the eyes move

[1] *Annales d'Oculistique*, 1877, lxxviii., 116.
[2] "Miner's Nystagmus," Leipzig, 1912.
[3] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., lxxii.

in coarse, slow jerks when they are directed towards the side of the lesion, and in more rapid jerks of smaller range when they are turned away from the lesion.

This observation has been confirmed clinically in man, in cases of cerebellar disease, by Russell and others ; and in cerebellar and extra-cerebellar abscess by Sydney Scott.[1]

According to James Taylor, nystagmus may occur as a result of peripheral lesions in the nerves, as in alcoholic neuritis, or in the muscles, as in myasthenia gravis.

Lenoble and Aubineau,[2] under the term "Myoclonic Nystagmus," report a group of cases which is characterised by nystagmus associated with spasmodic movement of the head and body, quivering of the muscles, and increased knee-jerks.

It affects several generations, and may be accompanied by mental and physical deterioration.

(F) *Labyrinthine Nystagmus.*—In disease of the internal ear in which the semi-circular canals are involved nystagmus becomes a prominent feature.

It can also be elicited in normal individuals by excessive stimulation of the labyrinth, as by—

(1) Syringing the external ear with hot or cold water.
(2) By rotating the patient in a chair especially designed for this purpose.
(3) By passing a galvanic current through the head.

The resulting nystagmus is rhythmic, having a rapid and a slow component, is bilateral, and is horizontal or rotatory in type.[3]

If nystagmus be elicited by means of rotation in the rotatory chair, one or other of the semi-circular canals can be stimulated at will according to the position in which the head is placed, and the corresponding nystagmus produced.

The nystagmus is seen on stopping the rotation, and in direction is the opposite of that of the previous rotation (Scott).

Fridenberg[4] says : "It has been shown that stimulation of

[1] *Pro. Roy. Soc. Med.*, Sect. Neurol. Ophth. Otol. 1913, vii, xli.
[2] *Rev. de Méd.*, 1911, xxxi., 209.
[3] Scott, *Pro. Roy. Soc. Med.*, Sect. Neurol. Ophth. Otol. 1913, vii, xl.
[4] *Trans. Amer. Ophth. Soc.*, 1891, xi, 571.

the nerve terminals in the ampulla of a semi-circular canal produces a sensation of turning in the plane of that canal, and that the resultant nystagmus corresponds to the change of position of objects which would follow such a rotation of the individual."

"The sensation of turning is always towards the irritated side, and the rapid movement of the nystagmus is towards this side.

"In labyrinthine nystagmus, indicating irritation, nystagmus is increased on looking towards the affected side, and may disappear entirely on looking in the opposite direction."

Nystagmus can be evoked momentarily in some patients with middle-ear disease associated with a fistulous communication between the middle and internal ears.

This is done by sudden compression of the meatal contents.

It is essential that the neuroepithelium of the vestibule should be intact, and that the local condition is favourable to the transmission of sudden changes of pressure to the interior of the labyrinth ; this is known as the "fistel-symptom."

Immediately one labyrinth is rendered functionless, spontaneous rhythmic nystagmus towards the opposite side occurs ; this, however, at once ceases if the other labyrinth is destroyed (Scott).

Head Nodding and Nystagmus (Spasmus Nutans).—In small infants under a year old an association of nystagmus with rhythmic nodding or shaking movements of the head is sometimes seen. It is believed by some to be due to the children having been kept in ill-lit rooms. It occurs in the first year of life, and is more frequent in females.

The head movements precede the nystagmus by some weeks, whilst the nystagmus persists for a number of weeks after the head movements have ceased. The movements cease during sleep.[1] There is no associated disease of the eyes or nervous system, and the condition is always recovered from.

Distinct from the foregoing, Hancock[2] has reported a congenital and hereditary form of head nodding with nystagmus

[1] Hadden, *Lancet*, 1890, i, 1294.
[2] *Roy. Lond. Ophth. Hosp. Reports*, 1907-8, xvii., 112.

which commences at birth, persists throughout life, and is associated with defective sight. In one family he found six out of nine children affected.

RETINAL HÆMORRHAGES IN GENERAL.

Many and varied are the causes of retinal hæmorrhages, and whilst in some the immediate cause is readily appreciated, this is not so in all instances.

FIG. 11.—Showing hæmorrhages into the nerve fibre layer of the retina which mark out very clearly the texture of this layer. From a woman of fifty years of age whose systolic blood pressure was 285 mm.

It is only proposed to offer a few general remarks here upon retinal hæmorrhages as such.

They vary greatly in number, in size, as to their position in the retina, whether near the disc or peripherally placed, and as to the layers of the retina involved.

They are usually most extensive over the central regions where the retina is thickest and the largest vessels are placed, and to the temporal rather than the nasal side of the disc.

As to site, it is to be remembered that the retinal vessels do

not penetrate deeper than the external molecular layer, and consequently hæmorrhages will tend to be most frequent in the inner layers of the retina, but larger effusions may infiltrate all the layers ; the most external retinal layers are nourished by the choroid and in some animals no retinal vessels exist.

A special type of hæmorrhage is that which occurs in the yellow spot region between the nerve fibre layer and the internal limiting membrane, it is of the shape of a half-moon

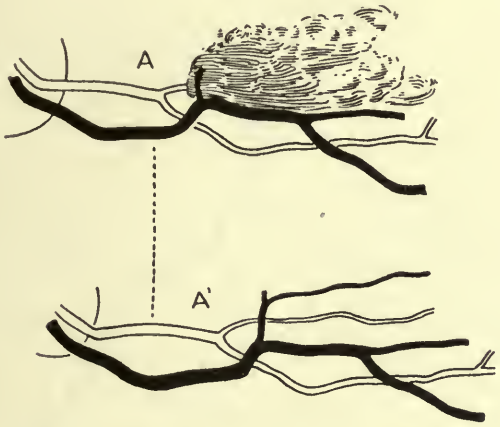


Fig. 12.—A gross hæmorrhage of heterogeneous texture, which was probably infiltrating all the layers of the retina, in a woman whose systolic blood pressure was 205 mm. The second drawing (*A'*) was made two years and six weeks after the first; the retina over the area previously involved showed a few minute bright dots, but otherwise no sort of abnormality was present; there was no residue of the previous hæmorrhage. There was nothing to indicate with certainty the source of the previous bleeding, but the artery which traverses the area showed marked variability of calibre.

with a perfectly sharp horizontal upper margin. It is spoken of as a subhyaloid hæmorrhage ; I have seen this type of hæmorrhage on three occasions in leukæmia.

When effusion of blood takes place in the nerve fibre layer it shows up the texture of this layer ; the hæmorrhages resulting are often likened to tongues of flame, and so are spoken of as " flame-shaped " (Fig 11).

When the hæmorrhages are in the deeper parts of the retina

they tend to be roughly circular in outline, and do not show the striate texture of the more superficial flame-shaped ones.

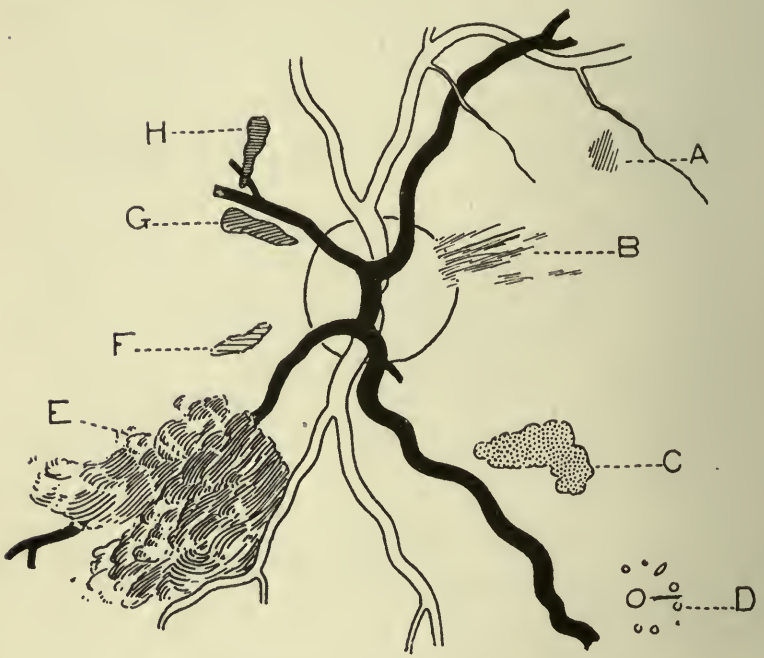


Fig. 13.—A composite diagram to indicate the length of time required for the disappearance of different types of retinal hæmorrhage. The hæmorrhages of different types have been collected from their proper notes and incorporated here. The time given dates from the occasion when the hæmorrhage was first seen. *A.* A small deep hæmorrhage; it had gone in eight weeks. *B.* A flame-shaped hæmorrhage; no trace was left in thirty days. *C.* An irregular hæmorrhage which disappeared in seven weeks. *D.* What appeared to be small globules of blood in the retina; they were still present, and but little, if at all, changed two years and ten months later. (I have several times seen blood in relation with the non-vascular parts of the eye, the vitreous or lens capsule, remain bright red and apparently unchanged for long periods up to six years.) *E.* The area was mottled with blood at the end of four months (*cf.* Fig. 12). *F.* No trace left after three and a half months. *G.* Slight traces still present after three months. *H.* Completely gone in two months.

Most hæmorrhages are of homogeneous red colour, but often in leukæmia and sometimes in other conditions some have a pale nucleus-like centre; large dense hæmorrhages are often

dark and have a slaty hue over their central parts, and many large single hæmorrhages have a mottled red and white appearance (Figs. 12 and 13; *E*).

All hæmorrhages tend to become absorbed, but in many diseases new ones develop as rapidly as the old ones clear, so that the retina is never free of their presence.

In the great majority of cases, hæmorrhages as seen ophthalmoscopically gradually become smaller and simply fade away without undergoing change of colour, till ultimately no trace of their former presence is left.

This is also true of large hæmorrhages (Figs. 12 and 13, *E*); if, however, the external limiting membrane is transgressed, pigmentary disturbance will be evident after the blood is absorbed.

As would be expected, the time taken for the absorption of hæmorrhages varies with their size and density.

In Fig. 13, individual hæmorrhages which disappeared under observation have been incorporated in one composite figure, in which the size and texture of the hæmorrhages has been indicated approximately, and the time of complete disappearance noted.

Apart from well-recognised causes, retinal hæmorrhages occur in what seems to be an accidental sort of way; for example, in patients who are apparently quite healthy; or a patient who is emaciated, or seriously ill from any cause, may be found to have developed one or two small hæmorrhages into the retinal tissues.

THE HEMIANOPIC PUPIL REACTION.

This reaction often goes by the name of Wernicke's pupil reaction. The term implies that in cases of hemianopia, upon throwing light on to that half of the retina which corresponds to the blind half of the field of vision, the pupil does not contract, whereas it does contract when light reaches the opposite half of the retina.

The test is supposed to be of value in distinguishing a hemianopia due to a lesion in front of the mid-brain, from one in which the lesion is posterior to the mid-brain.

Experimental investigations upon the area of the retina which, on stimulation by light will cause contraction of the pupil, are not altogether in accord ; the difficulty arises from the impossibility of stimulating one localised spot without the rest of the retina being simultaneously stimulated by diffusion within the eye.

Hess [1] investigated the matter by alternately impinging a beam of light on the optic disc, and then on other parts of the retina which were equidistant with it from the yellow spot.

In all cases the diffusion of light within the eye was the same, but in the first instance no light percipient elements were directly stimulated, yet the pupil contraction was the same as when light was thrown on to parts of the retina in which light percipient elements were present ; the deduction is that the pupil contraction in all cases was due to intra-ocular diffusion of light stimulating the yellow spot and its immediate vicinity.

Hess comes to the conclusion that no pupil contraction could be called forth by his method outside a circle of 3 mm. radius from the macula.

These conclusions were in part confirmed by Hesse.[2]

Hesse indeed succeeded in showing that with a powerful light the pupil could be made to contract by stimulating the retina at 45 degrees from the yellow spot ; he concludes that whilst he has shown that the hemianopic pupil phenomenon is theoretically possible, it has no practical application.

Henschen [3] believes it is of value, and analyses the precise site of the lesions which may produce it.

Best [4] from clinical considerations, adds weight to the view that the pupillomotor and visual functions of the retina are co-terminous.

He reports a case in which with only a small peripheral island of visual field left, the pupil contracted well to light, and points out how close is the parallelism between the brightness of light and the pupil reaction in disease of the optic nerve and retina.

[1] *Archiv. f. Augen.*, 1907, lviii., 182.
[2] *Klin. Monats. f. Aug.*, 1909, xlvii., 33.
[3] *Klin. und Anat. Beiträge zur Pathol. des Gehirns, Theil*, iii.
[4] *Archiv. f. Augen*, 1908, lxi., 319.

Thus he states, with retro-ocular neuritis, he has seen blindness associated with impaired pupillary reactions, and with the gradual return of vision there has always been a corresponding pupil reaction.

He concludes that it cannot at present be decided from physiological or pathological investigation whether there are special pupillomotor fibres or not.

I have many times applied Wernicke's test in cases of chiasmal lesions, but have never found a convincing result, or reaped any advantage from it. I have not used the elaborate apparatus of the physiological investigators.

At the present time it may be concluded with Hesse that whilst the hemianopic pupil phenomenon is theorctically possible, it has no practical application, and on account of the fallacies which attach to earlier methods, the results hitherto reported are of no value.

BI-NASAL HEMIANOPIA.

The occurrence of visual fields of such kind as to justify the term bi-nasal hemianopia is unusual, and when it occurs the evidence goes to show that it is always due to a lesion at or in front of the chiasma, for most have been cases in which papill-œdema or a consecutive nerve atrophy has been present, and in none has there been a sharply divided field at all comparable with that seen in cortical lesions.

The possibility of an anatomical variation in the crossing of the fibres may be had in mind, for should such variation take the form of a complete decussation, as occurs in some animals, a pituitary tumour would be likely to result in bi-nasal rather than in bi-temporal defects.

Frequency.—The condition is not so rare as might be supposed, for Cushing and Walker,[1] amongst 300 cases of intracranial growths, found nineteen which exhibited a tendency towards bi-nasal hemianopia ; they state " it occurs as a late sequel of an advanced choked disc in the stage of recession of the œdema, and a bilaterally symmetrical process, implying

[1] *Archiv. of Ophth.*, 1912, xli., 597.

an equal degree of involvement of the two eyes, suggests as a rule a distant, often a cerebellar lesion with secondary hydrocephalus.

Veasey [1] also has collected twenty cases.

The mechanism of production is attributed to pressure of the carotid vessels upon the outer aspect of the chiasma, either because the chiasma is forced outwards against the artery, or because the artery, being diseased, presses upon the chiasma; thus Cushing and Walker say "an internal hydrocephalus with distension of the third ventricle, crowds the optic nerves downward and outward against the carotid vessels which transversely indent the outer aspect of the optic nerves."

Knapp [2] suggests conversely, that the outer aspect of the nerves may be pressed upon by markedly diseased internal carotid or posterior communicating arteries, and nasal hemianopia or partial optic atrophy be so produced.

Heed and Price [3] state that of twenty-one recorded cases the lesion could be located in the optic nerve in fifteen. They report a case occurring in tabes, and similar cases are reported by Fuchs, and Lang and Beevor.[4]

THE RETENTION OF THE PUPILLARY LIGHT REFLEX IN CASES OF BLINDNESS.

There are a few conditions in which the pupil will contract to light stimulus even though the patient is sightless.

The most important examples of this are seen in uræmic blindness (p. 158); the amaurosis of post-basic meningitis (p. 203); and puerperal amaurosis (p. 138)—conditions which are believed to be due to the effects of toxins on the visual cortex.

Edmunds [5] reports the case of an idiot, aged two and a half years, who was said to be totally blind, in whom the fundi were normal and the pupils reacted well to light.

[1] *Ophth. Record*, 1897, 78.
[2] *Arch. Scient. and Pract. Med. and Surg.*, 1873, 293.
[3] *Jour. Amer. Med. Ass.*, 1914, lxii., 771.
[4] *Trans. Ophth. Soc. U.K.*, 1894, xiv., 248.
[5] *Path. Trans.*, 1881, xxxii., 4.

On post-mortem examination the cerebral hemispheres and optic thalami were very small, and from an examination of the specimen in the museum of St. Thomas' Hospital, Nettleship says: "I find the corpora quadrigemina are quite healthy-looking and plump, contrasting most markedly with the adjacent optic thalami," a point which lends weight to the view that the corpora quadrigemina are not concerned with the actual act of seeing (p. 108); it is of interest, however, to remember that in animals in which it would seem that sight is of preponderating importance, such as birds and reptiles, the superior corpora are particularly well developed, suggesting that they are concerned in an important way with the functions of sight.

Cases of optic atrophy from which the patients were blind, but in which the pupils dilated in the dark and contracted in sunlight, are reported by Harlan [1] and Myles Standish and de Schweinitz.

INDIRECT PARALYSIS OF CRANIAL NERVES.

It is well recognised that intra-cranial lesions, be they tumours, inflammations, or some less tangible form of disease, are not infrequently associated with paralysis of cranial nerves with which no obvious direct relationship exists; the vulnerability of the sixth nerve in this respect is notorious.

Thus tumours in any part of the cerebrum, where it seems any direct connection with the sixth or third nerve can be excluded, may, nevertheless, be accompanied by paralysis of one or both of these nerves; they, too, are often involved in cases of meningitis, where post-mortem there seems to be no sufficient reason for their selective implication, and the picking out of the sixth nerve in cases of spinal anæsthesia seems to call for special elucidation.

Harvey Cushing [2] says: "It is a matter of common knowledge that ocular palsies, either stationary or fluctuating in their intensity, particularly those manifested by a convergent squint, are so often misleading from the standpoint of topographical

[1] *Trans. Amer. Ophth. Soc.*, vii., 672.
[2] *Brain*, 1910, xxxiii., 204.

diagnosis, that they have come to be classed with the "false localising signs" of tumour.

Thus, James Collier [1] found that false localising signs attributable to the "indirect intra-cranial results of intra-cranial new growth" were present in 12·5 per cent. of his 161 cases.

He emphasises the fact that the sixth nerve is much more frequently implicated in this way, and that it was affected in twelve of his cases in which the tumour was situated above the tentorium.

Paralysis of cranial nerves, and especially of the abducent, has resulted in quite a number of cases from spinal anæsthesia. It is usually a paresis only, it comes on within an hour or two of the administration, and is usually slowly recovered from in the course of many weeks. Reber [2] reports five such cases amongst 2,000 spinal anæsthetics, in nearly all of which stovaine was used. He collects thirty-six cases which have been reported, and in all but four of these it was the external rectus muscle alone which was paralysed.

Explanations.—Several theories have been propounded to explain these lesions, the oldest and least satisfying attributing the vulnerability of the sixth nerve to its long intra-cranial course.

Collier says: "If the paralysis of these nerves is the result of shifting backwards of the brain stem from supra-tentorial pressure, the effect being traction on the nerves attached to the brain stem in proportion as their direction is more nearly a fronto-caudal direction, then the shifting backwards on the brain stem would cause paralysis of the sixth nerve first, then of the third, and lastly of the seventh and eighth, whilst the nerves which are transversely directed, or with sinuous course, would be little affected."

Cushing, however, offers an entirely different explanation.

He points out that as the sixth nerve runs directly forwards from the hind margin of the pons, it meets the anterior inferior cerebellar and internal auditory arteries at right angles, as they course directly outwards from the basilar artery (Fig. 14).

[1] *Brain*, 1904, xxvii., 490.
[2] *Jour. Amer. Med. Ass.*, 1910, lv., 380.

In many cases these vessels lie ventral to the nerve, so that the latter is crossed by them at right angles, and is liable to compression between them and the pons.

He shows how acute may be the constriction produced in this way (Fig. 14), and he believes that in cerebellar lesions for instance, the swelling and enlargement of the hind brain may produce such a stretching of the arteries around the brain

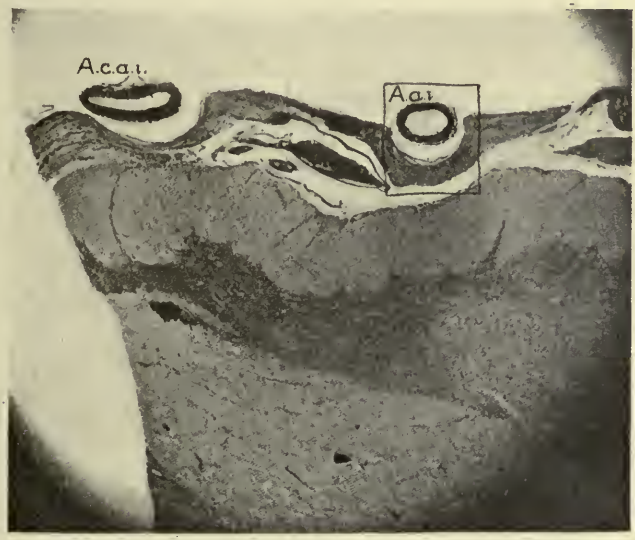


FIG. 14.—An antero-posterior section through a part of the pons, showing how acutely the sixth nerve may be indented where it is crossed at right angles by the anterior inferior cerebellar and internal auditory arteries, and so may have its functions interrupted. (Harvey Cushing.)

stem as to constrict the nerves, much as though a rubber band had been placed around them (Fig. 14).

He suggests that œdema of the brain stem may in this way be responsible for some cases of ophthalmoplegia associated with migraine, and for the paralysis following lumbar anæsthesia.

The third nerve has a very close relationship with cerebral vessels, in that as it passes forwards from the sulcus oculomotorius it separates the superior cerebellar from the posterior cerebral artery; and although there is no firm structure like the pons in the case of the sixth nerve, against which the nerve can

be compressed, it is possible that stretching of these vessels might produce a temporary inhibition of function in the third nerve by its being nipped between them.

In favour of the foregoing explanation it may be noted, that the sixth and third nerves are notoriously those which are most frequently involved in indirect paralysis, and it is just these two of all the cranial nerves which are in most intimate relationship with large cerebral arteries, and with arteries, too, which, being anchored ventrally by the basilar artery, tend to encircle the brain stem, and are, therefore, most likely to constrict the nerves if swelling of the brain occurs from œdema.[1]

MONOCULAR DIPLOPIA.

There are several conditions in the eyeball itself which may give rise to monocular diplopia ; such are astigmatism, opacities of the cornea or lens, or, under certain conditions, a double pupil.

Such cases are of little interest. A number of cases, however, have been recorded in which monocular diplopia was complained of, where there was no local cause in the eye to explain it, and in which, after careful and critical consideration, malingering and hysteria could be ruled out as the cause.

It is worthy of especial note that in most of these cases there has been a gross cerebral lesion which has resulted in some ocular palsy—usually the sixth nerve or nerves—with its accompanying binocular diplopia, and that the monocular diplopia has developed a little later as a sequel to, or an accompaniment of, the binocular diplopia.

Such cases have been reported by de Schweinitz,[2] Bouveret and Chapoto,[3] Thompson,[4] Brailey, Juler, Gulliver, and others.

Bielschowsky [5] reports the case of a man who had a squint, and who complained of diplopia after removal of one eye.

Three important cases are reported by Ord,[6] Abercrombie,[7]

[1] Foster Moore, *Pro. Roy. Soc. Med.*, Ophth. and Neurol. Sect., 1921.
[2] *Trans. Amer. Med. Ass.*, Detroit, 1892, 277.
[3] *Revue de Méd.*, 1892, xii., 728.
[4] *Trans. Amer. Med. Ass.*, Ophth. Section, 1891.
[5] Ophth. Soc., Heidelberg, 1897, 93.
[6] *Trans. Ophth. Soc. U.K.*, 1882, ii., 201 and 205.
[7] *Trans. Ophth. Soc. U.K.*, 1882, ii ., 210.

and Gunn and Anderson,[1] in which gross cerebral disease was present, and in two of which post-mortem examinations were made.

In all of these one or both sixth nerves were involved. In Ord's case, a lad of thirteen, both sixth nerves were affected, there was binocular diplopia, followed in a few days by monocular diplopia with either eye, which later on became limited to the left eye alone. He was examined by Nettleship from time to time, who states that the boy was sincere, but that there were reasons for suspecting that "his monocular statements were in some way based on his experience of binocular sixth-nerve diplopia," a remark which would seem to be appropriate to many of the cases. At the post-mortem examination a large cavity occupying the ordinary position of the lateral ventricle, with which a small aneurysm was communicating, was found in the right cerebral hemisphere.

Abercrombie's patient was a girl of ten; she had paralysis of the right external rectus, and complained of diplopia with both eyes, and also when the left was covered. She was examined on many occasions, and always with the same result as to the monocular diplopia. At the post-mortem a large abscess containing some ounces of pus was found in the right temporo-sphenoidal and occipital lobes.

Gunn and Anderson's patient was a man of thirty-four, with many evidences of gross cerebral disease. He had paresis of the left sixth nerve with homonymous diplopia, and also left uniocular diplopia; in the latter, as in the former case, one image being sharp and distinct, the other dim. It was not found possible to produce three images by means of a prism. The left pupil was larger than the right, which these observers say is not infrequent in cases of sixth nerve paralysis; they also comment on the disappearance of monocular diplopia when binocular diplopia is recovered from.

HÆMORRHAGE INTO THE OPTIC NERVE SHEATH.

It will be remembered that the supporting layer of the dura mater is carried outwards through the foramina of the skull to

[1] *Trans. Ophth. Soc. U.K.*, 1884, iv., 292.

become fused, after a short distance, with the sheaths of the vessels and nerves which traverse these foramina.

In the case of the optic nerve, however, the dura forms a roomy sheath which extends to the sclerotic, with which it becomes fused around the optic nerve entrance; the pia and arachnoid are also continued in a similar manner.

It comes about that the cranial subdural and subarachnoid spaces are in free and direct continuity with these spaces as they surround the optic nerve, the pial surface of the nerve is freely bathed by cerebro-spinal fluid as far as the back of the eyeball, and in this situation the sheath of the nerve dilates in a bulbous manner.

(Reference has already been made to the fact that the central retinal vessels, as they traverse this space, are subject to variations in the intra-cranial pressure through the medium of the cerebro-spinal fluid.)

If, then, from any cause blood is poured into the cerebral subarachnoid space, it is free to enter the continuation of the space to the back of the globe.

A common cause of this form of hæmorrhage is fracture of the skull, and in such a case, where blood is present in any quantity in the anterior cranial fossa, I have usually found the sheath to contain blood, and sometimes it is full of it.

Owing to the shape of the space with a bulbous dilatation at its distal end, the appearance is as if the cavity were forcibly distended; this, however, is not the case, for there is no forcing out of the blood when the nerve is cut across in the post-mortem room, nor is the apparent distension relieved thereby, though the contained blood is still fluid.

Hölder,[1] from 126 personally observed fractures of the skull, found that fifty-four had a fracture of the optic foramen, and forty-two of these had blood in the optic sheath. He states that he has never seen this in the absence of a fracture involving the optic foramen.

This, however, is by no means the case, for so long as there is blood free in the subarachnoid space, it is able to flow into the nerve sheath, regardless of the source of the bleeding.

[1] "Bericht der ophth. Gesellschaft," Heidelberg, 1879, 9.

I have seen it occur from the rupture of an aneurysm of the anterior cerebral artery (Fig. 15), and in a case of spontaneous meningeal hæmorrhage.

Liebrecht [1] found the condition in 55 per cent. of twenty-six cases of fracture of the skull.

In a case reported by Priestley Smith [2] the blood was entirely external to the arachnoid, the subarachnoid space being distended by cerebro-spinal fluid.

In some cases retinal hæmorrhages have been found, but I know of no statistics as to their frequency, and there are no signs which enable one to state with any certainty beforehand that hæmorrhage into the sheath is present.

The signs given by Dupuy-Dutemps [3] as being indicative of it are :—

Congestion of the disc and œdema.

Dilatation of veins.

Retinal hæmorrhages, variable in number and extent.

Vitreous hæmorrhages rarely ; and these he attributes to obstruction of the flow in the retinal vein where it traverses the space.

Fig. 15.—A case in which blood has flowed into the sub-arachnoid space of the optic nerve sheath. From a patient who died from the rupture of an aneurysm of the anterior cerebral artery.

Gonin [4] considers that a moderate degree of papillary stasis, with or without hæmorrhages along the retinal vessels, is suggestive of the condition.

It is exceedingly doubtful whether the presence of blood in the sheath *per se* in any way affects vision, nor is there evidence of its organisation.

Dupuy-Dutemps [3] says that a unilateral spontaneous sheath hæmorrhage as a cause of sudden blindness has never been verified.

[1] *Archiv. f. Augenheil*, 1906, lv., 36.
[2] *Trans. Ophth. Soc. U.K.*, 1884, iv. 271.
[3] *Annal. d'Oculist*, 1914, cli., 184.
[4] *Annal. d'Oculist*, 1903, cxxix., cxxx., 93.

When the optic nerve is divided as a result of a fracture involving the anterior cranial fossa, loss of sight occurs at once, but there are no immediate ophthalmoscopic changes in the optic nerve, unless the ophthalmic artery is also divided.

The signs of optic atrophy begin to appear at the end of about a month, and complete primary atrophy ensues.

THE RETINA AT DEATH.

The details of the fundus are clearly visible for a varying period, up to about fifteen minutes after death; after this time the cornea becomes too hazy for the details to be distinctly seen.

The whole fundus immediately after death shows a very marked general pallor, the disc having the whiteness of an advanced optic atrophy.

The retinal arteries are very rapidly emptied of blood in a direction the reverse of the normal flow, and are reduced to very fine white lines which are scarcely visible; the veins are greatly reduced in calibre, but contain a column of blood which soon becomes broken up into sectors of red cells, separated by clear spaces, giving rise to a beaded appearance.

For a few minutes after death, slow movement—visible streaming—of the blood in the veins can be seen, before the column becomes broken up, and shortly afterwards the blood can be seen to flow *backwards* along the arteries towards the disc until they are empty.

Usher [1] examined six patients immediately before, during and after death.

He describes the gradual development of the beaded appearance of the blood column in the veins.

At first, instead of the normal homogeneous appearance, the column of blood comes to have a finely granular, and later a more coarsely granular appearance, still later beading occurs, the blood column being broken up by clear spaces as already stated.

He has seen the "visible streaming" in the arteries *towards the disc* before respiration ceased.

[1] *Ophth. Review*, 1896, xv., 339.

The explanation of these appearances given by Usher, is that the slowing of the circulation in the retinal veins is of such a degree, as to allow the individual red blood cells to become visible under the magnification obtained by direct ophthalmoscopy.

The large granules being groups of red corpuscles, the smaller being individual cells.

A marked lowering of the intra-ocular pressure may be present as soon as one minute after death (Usher): I have shown that the intra-ocular pressure in normal individuals is reduced by about 40 per cent., within a few seconds of occluding the common carotid artery by compressing it against the transverse process of the sixth cervical vertebra.

For a long time the broken blood column in the veins can be made to shift to and fro within the vessels by intermittent pressure on the globe.

The diary of a man who committed suicide by suffocation with charcoal fumes [1] is of a little interest as indicating the stage at which vision becomes affected in such a case.

The subject was a man of fifty-three, who wrote down his symptoms and the time at which they occurred. Thus:—

3.40 (First note) giddiness and pain in head.
3.50 Body becoming numbed.
4.10 Pain in head gets worse, difficulty with breathing.
4.30 Sight getting dim.
4.40 Head aches, can't see anything.
5.10 (Last note) a domestic request.

Thus consciousness was retained for forty minutes at least after vision was affected.

In executions by hanging, dislocation of the crystalline lens of the eye frequently results.

[1] *Daily Chronicle*, December 11th, 1911.

CHAPTER II

Arterio-sclerosis—Pernicious anæmia—Leukæmia—Chloroma—Chlorosis—Secondary anæmias—Purpura—Raynaud's disease—Serious loss of sight from loss of blood—Erythræmia (Vaquez's disease)—Cyanosis retinæ—Retinal hæmorrhages in new-born infants—Thrombosis of retinal veins—Thrombosis of the cavernous sinus.

ARTERIO-SCLEROSIS.

In general arterio-sclerosis the retinal arteries of course share, and whilst it is not possible in all cases to detect any evidence of the disease with the ophthalmoscope, in the great majority it is possible to do so; consequently arterio-sclerosis it is one of the diseases often first discovered by the ophthalmologist.

The retinal vessels can be examined during life with a minuteness that is not possible with any other vessel in the body, for they are seen with great distinctness and under a magnification of about 15 diameters—*i.e.*, the magnification obtained by direct ophthalmoscopy—thus, changes in their structure are readily detected and the progress of the changes can be traced.

Following Gunn, the changes which occur have been studied by many observers, physicians and ophthalmologists.

My own observations are largely based upon a batch of sixty-six patients which were collected at the Moorfields Eye Hospital,[1] all of whom I had under more or less constant observation for at least six years, or till the time of their death, the longest time for which a patient was watched being thirteen years.

I have recently reviewed this group of patients afresh, and of them thirty-eight are known to be dead, the cause of death being known in thirty-seven; fourteen have been re-examined, and the remaining fourteen I have been unable to trace.

[1] *Quarterly Journal of Medicine*, 1916, x., 29.

The retinal changes are best considered under two heads :—

(1) Retinal arterio-sclerosis.
(2) Arterio-sclerotic retinitis.

(1) Retinal Arterio-Sclerosis.—The first change which is observable, but by no means the most reliable, is an increase in the brightness of the reflex from the retinal arteries, giving them a burnished appearance, an appearance to which the term " copper wire arteries " is sometimes applied.

The development of this appearance is probably coincident with the commencement of thickening of the middle coat of the artery.[1]

It is chiefly of value when the branches of the second and third dimensions are involved, and is especially significant when the central light streak has a finely beaded appearance.

This is a sign which needs a more than usually critical examination, for in its initial stages it is only an exaggeration of the normal appearances, and consequently it should only be considered of importance when it is particularly well marked and evidently pathological.

Arterio-Venous Crossings.—As the thickening of the arterial coat increases so the vessel becomes less transparent.

Under normal conditions, when an artery crosses a vein, the vein is visible right up to the coats of the artery on each side, and sometimes it may be seen faintly through the artery as it crosses underneath it.

As the arterial walls become thickened, not only is the vein quite invisible where it lies deep to the artery, but also for some distance on each side, the thickened arterial coats completely hiding it from view.

At a more advanced stage a further manifestation is developed at these crossings.

At first the vein is hidden from view under the artery, but its course is not interfered with, as however the thickening and rigidity of the artery become increased, the course of the underlying vein becomes diverted.

[1] Coats, *Trans. Ophth. Soc. U.K.*, 1913, xxxiii., 37.

In a case of severe sclerosis the vein, though meeting the artery at an angle of, say, 30 degrees and leaving it at a similar angle, passes under it at right angles to its course (Figs. 11 and 19).

The effect attained is, that the vein, instead of taking a long oblique course under the artery, traverses from one side to the other by the shortest possible route ; a similar phenomenon may be seen when a vein crosses over a sclerosed artery (Figs. 11, 16 and 19).

When this phenomenon is seen, it is safe to assert that the sclerosis is of a high or very high degree. I have watched one of these crossings remain unchanged for four years, and whilst it would seem that the flow through the vein must be obstructed, there was no dilatation of its peripheral portion, and no hæmorrhages in its territory ; I am convinced that any appreciable distension of the peripheral portion of veins in these circumstances, a condition to which the term banking is sometimes applied, is of quite unusual occurrence.

Fig. 16.—To show the riding of a vein over a thickened artery in the retina. The shaded band on each side of the artery indicates its visible coats. From a man of sixty-five whose systolic blood pressure was 265 mm. The appearances were quite unchanged at the end of two years.

Irregularity of Lumen.—In some cases, as sclerosis of the artery increases, its lumen, as judged by the contained column of blood, ceases to be of uniform calibre and comes to show narrowings in its course.

These narrowings usually develop somewhat gradually as the vessel is traced along, until the lumen may be reduced to one-half or less of its original diameter; it then dilates again to its former size, and this process may be repeated several times in the same vessel as it is traced towards the periphery (Fig. 17). I have kept a considerable number of these individual constrictions under observation for several years, and have found that the artery and retina peripheral to them may remain quite unaltered for long periods.

Fig. 17 represents the retinal arteries of a woman seen on

September 13th, 1913, and on March 4th, 1916, there was no discoverable alteration in the condition of the vessels.

I have watched a marked degree of irregularity of lumen develop in eight months in a soldier who had renal retinitis associated with trench nephritis. The presence of this irregu-

Fig. 17.—Showing marked irregularity of lumen of the retinal arteries (*A*) from a woman of fifty-seven, whose systolic blood pressure was 218 mm. She died of "an acute heart attack" four years and five months after the drawing was made. At the end of two and a half years the condition was quite unchanged, the individual constrictions being unaltered. See charts of visual fields, Figs. 24 and 25.

larity of lumen is always an indication of a high degree of arterial change.

It has been shown by Coats [1] that the above appearances are due to a proliferation of the endothelium with little or no ground substance between the cells; it is characteristic for this

[1] *Trans. Ophth. Soc. U.K.*, 1904, xxiv., 165; 1913, xxxiii., 30.

form of the disease to encroach on the lumen in an eccentric manner.

Coats also points out that the common form of disease in the central artery is confined in almost all cases to the endothelium and elastic membrane (Fig. 18), changes in the media being secondary, whilst in the branches in the retina the most common form of disease affects the media, giving rise to concentric constrictions of lumen and producing the bright copper wire ophthalmoscopic appearance (Fig. 21).

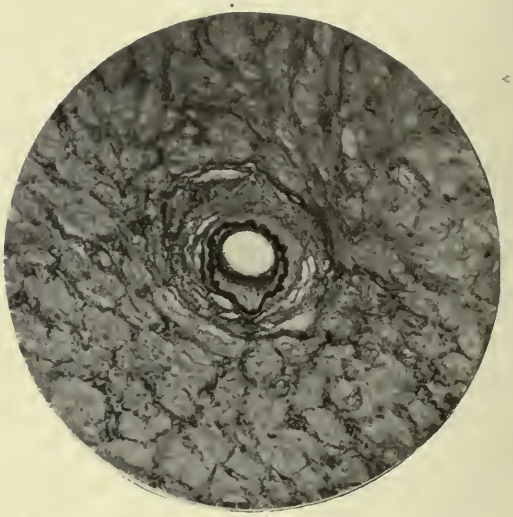


Fig. 18.—A section through the central retinal artery within the nerve to show marked endarteritis. (Coats.)

Tortuosity of Arteries.—When the walls of an artery increase in thickness the artery is necessarily increased in length, for one can hardly imagine the responsible elements increasing in one diameter only: it follows necessarily that the retinal arteries are increased in tortuosity in arterio-sclerosis; they, however, vary widely in their tortuosity under normal conditions, and consequently this change, pathological though it be, is by itself of no value in the identification of retinal arterio-sclerosis.

At times a very marked tortuosity of the small vessels in

the region of the macula is seen, and when it occurs it implies a marked degree of arterio-sclerosis, as was shown by de Schweinitz; it is, however, of infrequent occurrence, and consequently it must be considered as one of the less important signs.

A congested appearance of the disc is described by de Schweinitz [1] as one of the early signs.

Wendell Reber calls attention to a sluggish pupil reaction and abnormal recession of the near point.

Retinal Hæmorrhages.—Retinal hæmorrhages are of frequent occurrence where sclerosis of the retinal arteries is present. They are usually small and flame-shaped, being in the nerve fibre layer; some, however, occur in the deeper retinal layers and then are roughly circular in outline. They are always most profuse in the posterior parts of the eye where the vessels are biggest.

They are incidental to the arterial disease and their presence in general does not convey any specific significance; in some cases, however, an increase in their number precedes the onset of serious symptoms.

(2) **Arterio-Sclerotic Retinitis.**—After the condition of the arteries previously described has been under progress for some years, exudates in the retinal tissues may appear—*i.e.*, a condition of retinitis to which the term "arterio-sclerotic retinitis" is properly applied, becomes engrafted on the vascular disease (Fig. 19).

It is important to recognise, especially from the point of view of prognosis, that this retinitis is due to the local retinal vascular disease, and is quite distinct from renal retinitis, although the kidneys, like the other tissues of the body, share in the general disease, and albumen is frequently present intermittently in the urine.

The development, then, of these retinal exudates is to be considered as indicating a later stage in the progress of the disease of the retinal arteries.

The exudate takes the form of bright white dots or spots in the retina.

[1] *Trans. Amer. Ophth. Soc.*, 1906, xi., 87.

The individual spots are seldom of greater diameter than one of the main veins, but occasionally a few large plaques develop, in which cholesterin crystals may appear after a time.

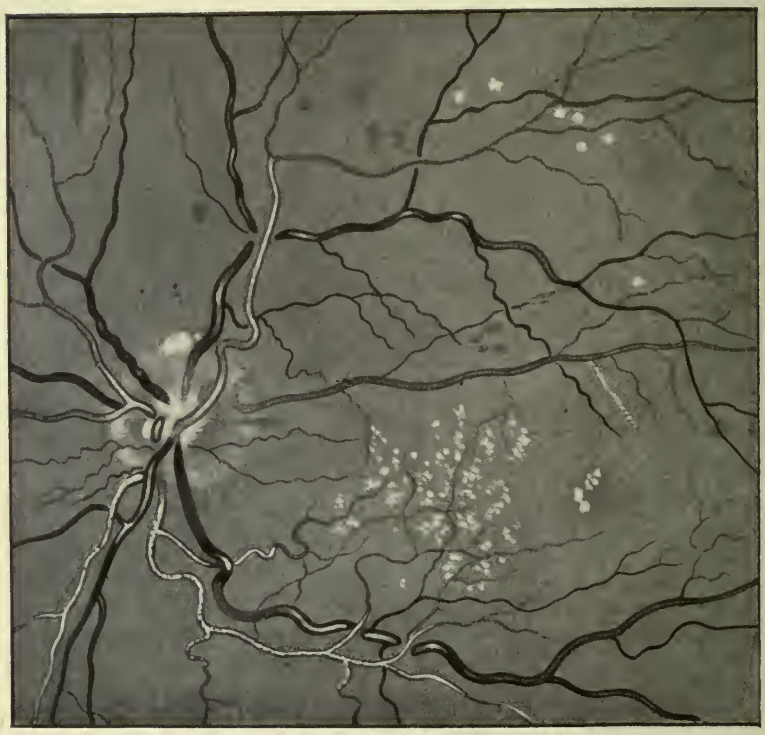


Fig. 19.—A case of arterio-sclerotic retinitis. From a woman aged sixty-five, whose systolic blood pressure was greater than 300 mm. She died of "a stroke totally blind" four years and four months after the drawing was made. The arteries are very bright, the lower one showing a dotted reflex, and when seen three years and one month later many of them were converted into fibrous threads. The veins are deeply cut into by the arteries; in one place a vein rides over a thickened artery. A few hæmorrhages and a number of the discrete dots of arterio-sclerotic retinitis are seen. The disc edges are blurred.

The spots are white, sharp edged, with no evidence of œdema around them, are roughly circular in shape and are seldom profuse (Fig. 19).

Sometimes they form a star figure around the macula, or a

fan-shaped figure between it and the optic disc, at other times they are definitely grouped around the radicles of the veins, but in most cases no such arrangement is discernible.

They are sharp edged and stable-looking, and are very slow to undergo change; in quite a number of cases, however, I have watched them disappear in the course of several months, and leave no trace behind [1] (Fig. 53, *C* and *D*, p. 157), or, as some disappear, fresh ones occur, and by this means, and by the development of fresh hæmorrhages as the older ones are absorbed, the ophthalmoscopic picture may preserve its general appearance for months or years.

In several individual cases I have watched the evolution of this form of retinitis from a case of uncomplicated retinal arterio-sclerosis; thus I still have under observation, *i.e.*, for more than thirteen years, a woman, who in 1908, was under the care of Marcus Gunn and later under George Coats; at first she had well-marked signs of retinal arterio-sclerosis only; there was no albumen in the urine. Three years later she had small white spots round the macula and a cloud of albumen in the urine; spots of this same type have been present ever since, the urine has usually contained albumen, and the blood pressure, which was 250 seven years ago, is now 270. At the present time, thirteen years since she was under the care of Marcus Gunn, she still has arterio-sclerotic retinitis, but is in moderate health and walks to hospital.

Not only may this evolution be traced in individuals, but amongst my sixty-six patients there were thirty-five who had retinal arterio-sclerosis only, and thirty-one who, in addition, had retinal exudates, *i.e.*, they had "arterio-sclerotic retinitis," and an analysis of these two groups showed what one would expect to find were the latter evolved from the former, for the blood pressure was higher, the incidence of cerebral vascular lesions was more frequent, and the mortality was greater in the group in which retinal exudates were present in addition to the vascular disease.

Unilaterality.—In thirty-one cases of "arterio-sclerotic retinitis" it was unilateral in fourteen, *i.e.*, 45 per cent.

[1] *Quart Jour. of Med.*, 1916—17, x., 42.

Histologically.—These spots are situated in the outer molecular layer, and are composed of hyaline-looking material in the form of oval or circular masses which stain pink or purple in eosin and hæmatoxylin sections, and are deeply stained by orcein (Fig. 20).

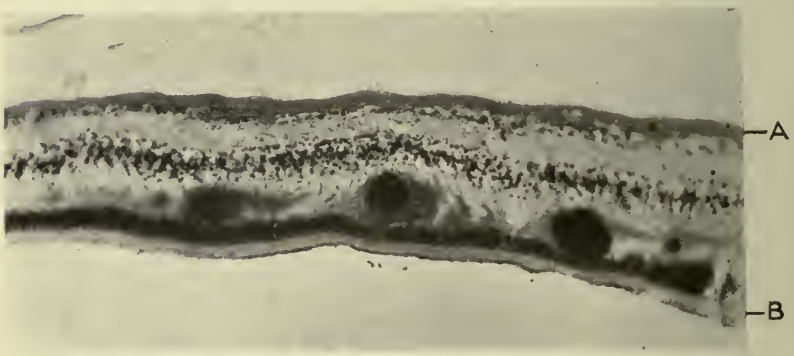


Fig. 20.—A section through the retina of a man whose systolic blood pressure was 240 mm., and who died of cerebral thrombosis. In the external molecular layer are three roughly circular masses of hyaline exudate deeply stained by orcein; they gave rise during life to the appearances of the white dots of arterio-sclerotic retinitis. *A*. The nerve fibre layer. *B*. The rod and cone layer.

It may be advantageous here to contrast renal retinitis with arterio-sclerotic retinitis:—

Renal Retinitis.	*Arterio-Sclerotic Retinitis.*
Due to disease of the kidney.	Due to primary vascular disease.
Distinctive ophthalmoscopic appearances.	Ophthalmoscopic appearances also distinctive.
Always bilateral.	Unilateral in 45 per cent.
Seldom survive two years.	Tenure of life uncertain, but may live a number of years.
Frequently die in uræmia.	Do not die in uræmia, but the cause of death is usually directly referable to vascular disease.

Other Changes in the Arteries.—As the arterial changes become more and more advanced, so the arterial lumen may

become reduced, until ultimately the artery is converted into a thin white cord containing no blood.

Pipe-stem Sheathing.—This is a condition in which a part of the length of the artery becomes surrounded by a solid white plaque of material apparently within the perivascular sheath, giving rise to a pipe-stem appearance.

It is quite distinct from the sheathing which may extend along the vessels for some distance from the disc.

In this condition the arterial lumen is in no way interfered with, and in spite of the very solid-looking appearance it completely disappears in time, and leaves not a trace of its previous presence.

The Retinal Arteries as a Guide to the Condition of the Cerebral Arteries.—Having regard to the method of development of the retina, it would be expected that the condition of its arteries would be a close guide as to the condition of the arteries of the brain, and this is undoubtedly the case.

The matter was investigated from two opposite aspects.[1]

On the one hand the incidence of gross vascular cerebral lesions was discovered in sixty-six patients who attended the Moorfields Eye Hospital for symptoms which were found to be dependent upon retinal arterio-sclerosis, and on the other hand the condition of the retinal arteries was examined in forty-four patients who were admitted to the wards of St. Bartholomew's Hospital suffering from a gross vascular lesion of the brain.

As regards the first group, the condition of fifty-two of the sixty-six patients was ascertained at the end of seven years.

Thirty-eight were known to be dead, and in thirty-seven of them the cause of death was discovered.

In seventeen it was either a cerebral hæmorrhage or thrombosis, and of the fourteen remaining, there was satisfactory evidence—such as hemiplegia or monoplegia—that six of them had developed vascular lesions of the brain.

Thus of fifty-two patients, twenty-three (44 per cent.) had in the course of seven years suffered from a gross vascular cerebral lesion which in seventeen instances was fatal.

[1] Foster Moore, *Quarterly Jour. of Med.*, 1916—17, x., 29.

Adams [1] from similar observations found a percentage of 45.

As regards the second group of forty-four patients. In all of them the diagnosis of the physician under whose care they were, was either cerebral hæmorrhage or thrombosis, and the

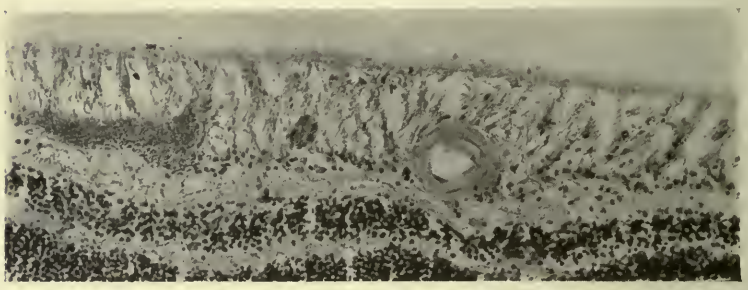


Fig. 21.—Section through a retinal artery of a man aged sixty-five, whose blood pressure was 240 mm. and who died of cerebral hæmorrhage (see also Fig. 22). During life his retinal arteries had an exceedingly bright and burnished appearance. Fig. 22 is from a section through the cerebral arteries of the same patient.

retinal vessels were examined after the use of a mydriatic with the following results :—

No evidence of arterio-sclerosis.	Evidence of mild or moderately severe selerosis.	Evidence of severe selerosis including arterio-selerotic retinitis.
13 (30 per cent.)	12 (27 per cent.)	19 (43 per cent.).

Thus of forty-four patients who were the subject of a gross lesion of the cerebral arteries, 70 per cent. exhibited evidence of disease in the retinal arteries, and in 43 per cent. it was severe in degree.

Similar observations on seventeen patients were made by Gunn,[2] who found definite evidence of disease of the retinal arteries in 59 per cent.

The close relationship which exists between disease of the retinal and of the cerebral arteries, then, is clear. It is probably true that where disease of the retinal arteries is patent to ophthalmoscopic examination, disease of the cerebral arteries

[1] *Brit. Jour. of Ophth.*, 1920, iv., 310.
[2] *Trans. Ophth. Soc. U.K.*, 1898, xviii., 376.

is certainly present, but that in a certain number of cases—30 per cent. according to the foregoing investigations—even advanced disease of the cerebral vessels may be present, though the retinal arteries reveal no evident disease to the ophthalmoscope.

Sclerosis of the choroidal vessels gives no information as to the condition of the cerebral vessels.[1]

Atheroma of the great Vessels.—With a view to determining whether there were any vascular or other changes of the eye associated with atheroma of the great vessels, the fundi of

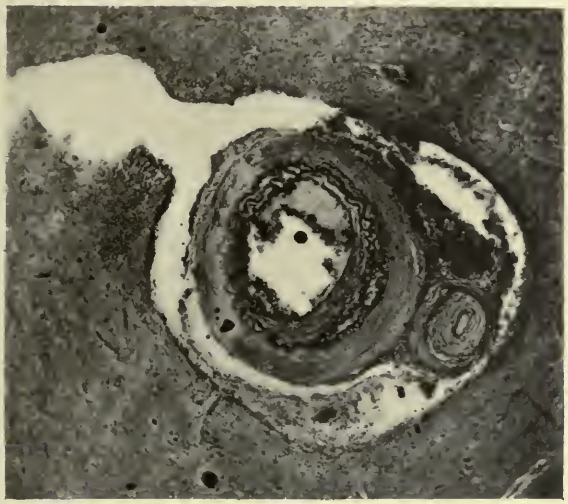


FIG. 22.—Section of one of the arteries of the anterior perforated space of a man aged sixty-five, whose systolic blood pressure was 240 mm. and who died of a cerebral hæmorrhage. Fig. 21 shows a section of a branch of the retinal artery from the same patient.

twenty-one patients, all of whom were males suffering from intra-thoracic aneurysms, were examined.

The age of the men varied between thirty-six and sixty-one; the average systolic blood pressure was 141 mm.

There was no evidence of any considerable disease of the retinal arteries in any case.

In four it was noted that the veins were a little full, and in

[1] Geis, *Klin. Monats. f. Aug.*, 1911, lxix. 14.

one the arteries are marked as being a little bright, but apart from these the vessels are all noted as being quite normal.

In three cases there was evidence of past syphilitic disease of the eye.

Prognosis.—The tenure of life of patients who are the subject of retinal arterio-selerosis is uncertain, but a considerable number of them live for several or many years.

Retinal hæmorrhages are incidental to the local retinal

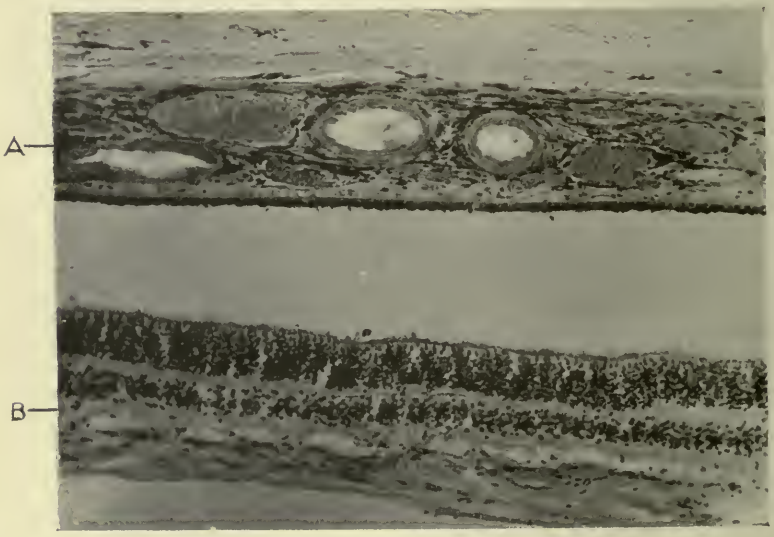


Fig. 23.—A section through the retina and choroid to show a mild degree of degeneration in the choroidal arteries. *A*. Choroid. *B*. Retina.

vaseular disease, and unless they are profuse do not add gravity to the prognosis, except in so far as they are more frequent in the more severe cases.

On the other hand, as has been pointed out, arterio-selerotic retinitis is to be looked upon as an indication of a further development of the vaseular disease, and eonsequently its presence does imply a more serious prospect, for of thirty-five patients with retinal arterio-selerosis, eight were known to have died, and nineteen were known to be alive, and after the same

interval, of thirty-one patients with arterio-sclerotic retinitis, sixteen were known to have died and twelve were known to be alive.

The prognosis of this latter, however, differs markedly from that implied by the presence of renal retinitis, for of seventeen women, ten were known to be alive for an average of three years and five months after the onset of symptoms, and of eleven males, two are known to be alive for an average of two years and ten months after the onset of symptoms, periods which much exceed the length of survival after the discovery of renal retinitis.

As regards retinal arterio-sclerosis in general, Adams concludes that the prognosis is dependent upon the associated renal and cardiac changes, that it is aggravated by the presence of albuminuria, and that it is better in older patients.

Sex Incidence.—If one judges from the eye manifestations of arterio-sclerosis, the condition is certainly more common in women, and in them the highest degrees are seen—they seem to be more tolerant of high blood pressure than men.

Of sixty-six patients there were ten whose systolic blood pressure was higher than 250, and of them seven were women. In the case of one woman the blood pressure taken each month for six months was greater than 300 mm. on five of these occasions. She lived for four years and four months after the time she came under observation, and died of "a stroke."

The observations of Gunn, Adams and Nettleship are all in accord with the above.

The Complications of Sclerosis of the Retinal Arteries.—*Amaurosis Fugax* may be conveniently considered here.

This term is applied to paroxysmal attacks of blindness, which usually affect one eye only at a time, and are followed by recovery of vision in periods varying from a few minutes to several hours. In most cases it is ascribable to local arterio-sclerosis, but this may produce the effect in more than one way. In some cases it would seem that spasm of the artery occurs; the nutrition of the retina is temporarily interrupted, with consequent loss of its function; recovery of vision follows as relaxation of the spasm takes place.

Noyes [1] says: "In consequence of vaso-motor irritation the retinal artery may be firmly contracted and arrest completely the circulation." Hughlings Jackson observed spasm of the arteries during an epileptic fit. Parisotti [2] saw constriction of the upper retinal artery, with corresponding loss of the lower part of the visual field in a case of ophthalmic migraine.

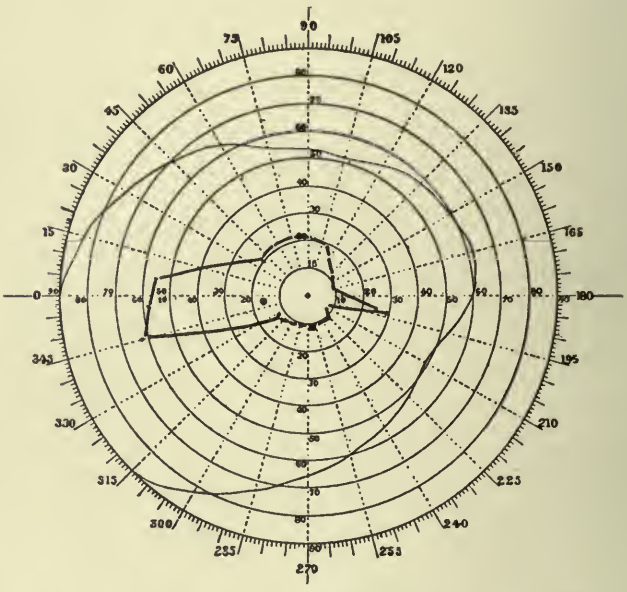


FIG. 24.—To show the entirely irregular nature of the defects in the visual fields resulting from severe sclerosis of the retinal arteries. From a woman of fifty-seven whose systolic blood pressure was 218 mm., and who died four years and five months later from an "acute heart attack." For condition of the arteries see Fig. 17.

Farabelli [3] reports a case due to the presence of a tape worm in the intestine. Greenwood [4] believes that spasm occurs most often in the early stage of arterio-sclerosis.

Sachs describes [5] peristaltic-like constrictions which followed

[1] "Diseases of the Eye," 1890, 546.
[2] *Ann. d'Ocul.*, cxix., 323.
[3] *Ann. di Ottal.*, xvi., 63.
[4] *Jour. Amer. Med. Ass.*, 1905, xliv., 781.
[5] *Beiträge zur Augenheilk.*, 1901, xliv., 323.

each other along the course of the artery. Wagemann [1] examined the retinal vessels of a man of sixty-nine who was the subject of arterio-sclerosis during an attack of loss of sight. He was quite blind and the arteries were reduced to fine threads. In thirty minutes the arteries were again well filled and vision was restored ; Langdon [2] reports a somewhat similar case.

It would seem then that the occurrence of spasm is substan-

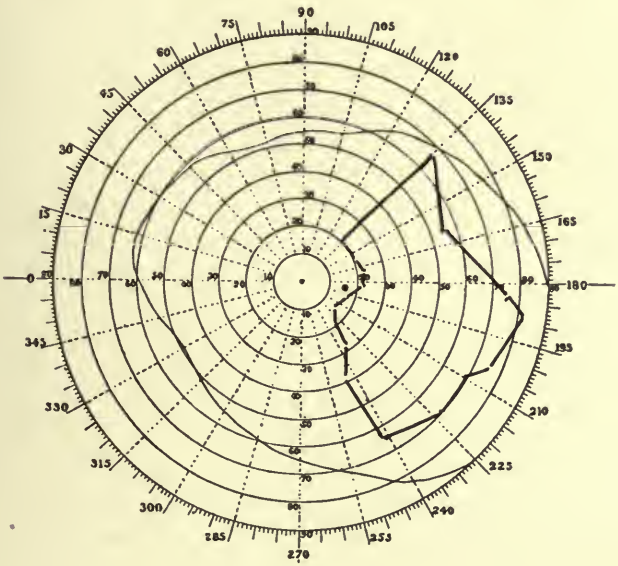


FIG. 25.

tiated although it is seldom seen, and as has been pointed out (*vide supra*), localised constrictions in the arteries, which are due to organic change—for they may remain quite unaltered for a number of years—may strongly suggest a localised spasm and are often associated with damaged sight.

In other cases loss of sight is more directly attributable to sclerosis of the arteries.

It has to be remembered that a systolic blood pressure of,

[1] *Graefe's Archiv. f. Ophth.*, 1897, xliv., 219.
[2] *Trans. Amer. Ophth. Soc.*, 1912, xiii., 797.

say, 250 mm. in the brachial artery, does not necessarily imply that the pressure in the retinal artery is above the normal, and I have pointed out,[1] indeed, that there is little doubt that in many, perhaps all cases of severe arterio-sclerosis, the pressure in vessels of the size of the retinal arteries is actually less than the normal, a view which is confirmed by Priestley Smith.

This being so, the blood supply of the tissues is precarious and is easily disturbed, so that a drop in the general blood pressure from any cause, may result in the supply of blood to these tissues falling below what is essential to the continuance of their functions, and whilst such a happening in many organs might cause little observable effect unless prolonged, if the eye is involved the loss of sight cannot be overlooked.

Three chief results may now follow ; if the blood pressure is again restored the sight may be completely recovered ; if the ischæmia has been prolonged the retinal tissues may be so damaged that recovery does not take place ; and, thirdly, the vessel wall being diseased, thrombosis of the artery with permanent loss of sight may result.

Perhaps some cases of *Amaurosis Fugax* may be compared with intermittent claudication, the retinal arteries, owing to their diseased condition, being incapable of providing an increased supply of blood to the retina when the demands of increased function call for it.

Thrombosis of the artery is of by no means rare occurrence, and there is no doubt that many cases of so-called embolism of the central retinal artery are really of this nature.

James Taylor[2] says in this connection : " I have been struck with the fact that in many cases I have seen it was impossible to find any probable source from which an embolus could start."

The chief symptom is, the sudden painless loss of sight in one eye in a patient the subject of arterio-sclerosis ; the average blood pressure in nine patients in whom this happened was 225 mm. ; the blindness is permanent and essentially complete.

Within a very short time, opacity of the central parts of the

[1] *Trans. Ophth. Soc. U.K.*, 1916, xxxvi., 319.
[2] *Trans. Ophth. Soc. U.K.*, 1913, xxxiii., 3.

retina develops, due to coagulation necrosis of its tissues, and the macula shows up by contrast as a bright cherry red spot.

These changes have been seen to develop by de Schweinitz [1] within ten minutes of the occurrence of the stoppage of the blood supply.

In addition, the blood column in the vessels is broken up into small blocks of red cells with intervening clear spaces of plasma, a characteristic picture to which the term "cattle truck appearance" is applied; by this means it can be seen clearly that the circulation in the vessels is slow or intermittent.

In the course of about seven days the central parts of the retina again become clear and the cherry spot at the macula disappears.

Later on the optic disc undergoes atrophy and the retinal vessels become permanently reduced in size.

Optic Atrophy.—In cases of marked arterio-sclerosis the retinal blood supply may be gradually so reduced as a result of the local arterial disease that it is no longer sufficient for the needs of the retina.

In this case a gradual atrophy of the retina and optic nerve takes place with a gradual loss of sight.

A cherry-red spot does not occur, but a low degree of œdema of the nerve head may sometimes be seen and it may precede the loss of vision.

The field of vision is constricted in an entirely irregular manner, corresponding with the varying degree of involvement of the branches of the retinal artery (Figs. 24 and 25).

Of eight patients in whom this form of optic atrophy occurred, one only had a blood pressure of less than 200 mm., and the average for the eight was 227 mm.[2]

Otto Reinhard and Péchin and Rollin [3] have each described atrophy of the optic nerve from the direct pressure of a sclerosed internal carotid or ophthalmic artery (see also p. 40).

Glaucoma.—It is sometimes assumed that glaucoma, a disease which is characterised by an increase of the intra-

[1] *Trans. Amer. Ophth.*, 1912—14, xiii., 815.
[2] *Quart. Jour. of Med.*, 1917, x., 37.
[3] *Archiv. d'Ophthal.*, 1903, xxiii., 577.

ocular pressure, is dependent upon an increase of blood pressure; that, however, there is any connection between the two is denied by so high an authority as Priestley Smith.

The intra-ocular pressure is, of course, dependent upon the maintenance of the blood pressure, and it is quite easy to demonstrate, by pressure upon the carotid artery in man, that the pressure inside the eye can be temporarily reduced by this means by about 40 per cent.,[1] but it has been made clear that there is no relation between a high systolic pressure in the brachial artery and glaucoma.

Thus the blood pressure of fifty patients suffering from primary glaucoma, whose average age was fifty-six, was 157 mm., which cannot be considered excessive for patients of this age.

Conversely the average intra-ocular pressure of thirty-seven patients, all of whose blood pressures were less than 160 mm., was 14·3 mm., whereas that of twenty-six patients whose blood pressure was in every case greater than 220 mm., was 15·3 mm.; that is, in the latter group the intra-ocular pressure was 1 mm. higher only, although the average blood pressure was higher by 78 mm.[2]

In a good many cases of thrombosis of the central retinal vein, and in a few cases of renal and diabetic retinitis, glaucoma supervenes, and in so far as these conditions are associated with arterio-sclerosis the latter may be considered to have an indirect casual relationship with glaucoma; apart from this there is one general disease only with which glaucoma is directly associated.

A disease of an epidemic nature occurred in the region of Calcutta which, whilst a good deal like beri beri, was distinct from it; it was termed epidemic dropsy, and it is a point of some interest that a considerable proportion of the patients affected, developed chronic glaucoma, which seems to have been especially frequent in the 1909 epidemic.[3]

[1] Foster Moore, *Roy. Lond. Ophth. Hosp. Reports*, 1915, xx., 117.
[2] Foster Moore, *Roy. Lond. Ophth. Hosp. Reports*, xx., 115.
[3] Mitra, *Calcutta Med. Journal*, 1910, 41. Ghosh, *Calcutta Med Journal*, 1910, 121.

PERNICIOUS ANÆMIA.

It has been pointed out that in any severe anæmia, be its cause what it may, retinal hæmorrhages may occur; in pernicious anæmia it is unusual to find them absent.

In addition, there are other fundus changes of less conspicuous aspect, which are not distinctive. Of nineteen cases which I had under observation for periods up to three years, four were females and fifteen were males; the average age of the former was forty-five and of the latter forty-four.

The average red blood count was 1,223,800, the lowest being 530,000; the average percentage of hæmoglobin was 32·5, the lowest being 16; the average colour index was 1·31, the lowest being 0·7.

Of these nineteen cases retinal hæmorrhages were found in all but three; in some instances care was required for their discovery.

They are mostly small and flame-shaped, or roughly circular in outline, but larger ones may develop, and at times the retina becomes widely infiltrated with blood;[1] they are usually situated in the nerve fibre layer and amongst the ganglion cells, and occur only in the posterior part of the eye.[2]

Hæmorrhages having pale centres are not infrequent and small white, rather woolly-looking areas are sometimes seen (see also p. 77).

The retinal vessels are seldom reduced in size, but more often are somewhat engorged; this is occasionally rather marked.

The fundus may show considerable pallor, but this varies much, and there is often disparity between the degree of the anæmia and the pallor or otherwise of the fundus.

The optic disc is often pale; it was noted as being conspicuously so in seven out of the nineteen cases. It is probably only an expression of the general anæmia in most instances, but at times may represent an actual partial atrophy of the nerve consequent upon the areas of degeneration in the retina.

It is common to find that the retina and disc have a faint

[1] Stephen Mackenzie, *Trans. Ophth. Soc. U.K.*, 1882, ii., 40.
[2] de Schweinitz, *Trans. Amer. Ophth. Soc.*, vii., 655.

opalescent haze over them as if they had been smeared over with milk and water. This is probably an expression of the œdema described by de Schweinitz and by Sargent.[1]

Ransome and Mules [2] state that the tendency to retinal hæmorrhages commences when the corpuscles have dropped to 32 per cent. or thereabout.

LEUKÆMIA.

The retina, choroid and orbit are all at different times the seat of lesions in this disease.

Changes in the fundus as seen by the ophthalmoscope are so frequent as to be usual, and few, if any, patients die of leukæmia, without at some time showing ophthalmoscopic evidence of it, and this is true both of the lymphocytic and of the myelogenic varieties, whether they run an acute or a chronic course.

Incidence.—Of twenty-five patients suffering from leukæmia whom I examined from time to time, twenty were of the myelogenic variety and five of the lymphocytic.

Thirteen were females and twelve males. The average age of the females was 37·5 and of the males thirty-two; the youngest patient was a boy of eight suffering from the acute lymphocytic disease.

In the myelogenic disease the average number of red corpuscles was 2,986,700, and of white 484,700; in the lymphocytic variety the numbers were 2,250,000 and 35,200.

Amongst these twenty-five patients there were three only—one lymphocytic and two myelogenic—in whom the fundus was entirely free of any change, though in some of them it was slight.

The Ophthalmoscopic Changes.—The earliest and least conspicuous of the changes is an engorgement of the retinal veins, no other abnormality being present.

In two only of the twenty-five cases could it be said that the veins were certainly engorged to a degree which was pathological, and that no other change was present.

[1] *Archiv. of Ophth.*, 1892, xxi., 45.
[2] *Brit. Med. Jour.*, 1887, i., 1112.

Of the two sets of vessels the veins are engorged more often and to a greater degree than the arteries ; thus, of the cases in which the veins were engorged, the arteries also showed engorgement in 44 per cent. ; engorgement of arteries alone does not occur.

What may be called the second stage of the changes is by a long way the most common. It was present in four out of five lymphocytic cases, and in twelve out of twenty of the myelogenic ; thus it occurred in 73 per cent. of those cases in which ophthalmoscopic changes were present.

In this stage either the veins alone or the veins and arteries are distended, both sets of vessels are paler than normal, and they come to approximate each other in colour, and retinal hæmorrhages are present. The vessels look as if they contain diluted blood, and this appearance, together with the fact that there is less difference than normally between the colour of arteries and veins, is an expression of the anæmia, and may be seen in any case in which marked anæmia is present.

The veins are sometimes greatly engorged, turgid, and sausage-like ; they are cut into where they are crossed by arteries, but are not displaced laterally as occurs in arterio-sclerosis.

The arteries less frequently show marked engorgement, but not to the same extent as may occur in the veins.

The hæmorrhages vary much, they may be very extensive, or a careful exploration of the fundus may be necessary to find one. Sometimes they tend to surround the vessels, but frequently there is no particular arrangement of them.

They are small or medium in size for the most part, and may be flame-shaped ; or, if in the deeper retinal layers, roughly circular or rosette-shaped ; they may burst the external limiting membrane and become subretinal.

They not infrequently tend to be diamond-shaped with a pale centre, reminding one a little of an endothelial cell with its nucleus, and whilst this particular type of hæmorrhage is more often seen in leukæmia than in other conditions, it is not limited to this disease.

The appearance seems to be due to the aggregation of leucocytes in the central parts of the hæmorrhage.

The occurrence of spontaneous bleeding from the iris and ciliary body has been described.[1]

The presence of retinal hæmorrhages does not imply a more than usually grave prognosis, for it is not rare to find a complete clearing of the fundus during a temporary improvement in the patient's condition.

What we may term the third stage in the retinal changes, consists of a general leukocytic infiltration of the retina and

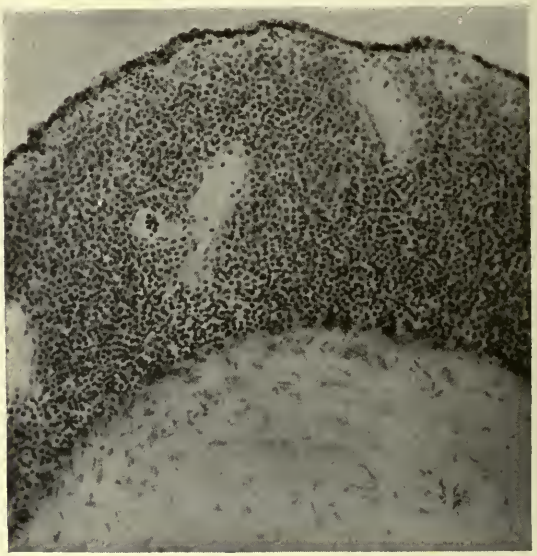


Fig. 26.—A section through the choroid and a part of the sclerotic from a case of leukæmia. There is profuse infiltration of the choroid, causing very great thickening of it.

choroid in addition to the changes previously described; as a consequence of this infiltration the fundus gives a pale or greenish reflex.

The term "leukæmic retinitis" should be restricted to this condition. It is not of common occurrence, for of the twenty-five cases referred to it was present in four only.

The veins may show broad white lines along them from perivascular infiltration; the lines may be as broad as the vein itself, and are widest along the convexities of the curves of the veins.

[1] Sorger, *Münch. med. Wochensch.*, 1898, xlv., 1120.

The disc edges are blurred from œdema. Hudson [1] describes disorganisation and degeneration of the nerve fibre layer, and the formation of cytoid bodies and the development of varicose nerve fibres, and these, together with masses of leukocytes, give rise to the white areas seen with the ophthalmoscope: see also Edmunds.[2]

If the changes are severe, narrowing of the visual fields and nyctalopia may occur. Deafness is sometimes present.

In a few cases leukæmic tumours develop under the conjunctiva causing a brawny mass to protrude between the lids,[3] or similar growths occur in the lachrymal glands or orbits, causing proptosis and limitation of movements.

Leukæmic infiltrations of the orbit are reported by Leber,[4] Kerschbaumer,[5] Werner [6] and Dunn.[7] Lagrange [8] has collected twenty-five cases of lymphoma of the orbit, and he points out that the symmetrical nature of the tumours is a fundamental characteristic. Cases of subconjunctival infiltration are reported by Meller [3] and Hudson.[9]

Two views are put forward to account for the origin of the leukocytic infiltration of the retina, choroid and orbit.

Stock [10] and Kerschbaumer [11] look upon passive infiltration by diapedesis and local proliferation as the source, whereas Türk and Meller attribute them to stimulation and overgrowth of pre-existing lymphoid elements.

CHLOROMA.

This is a rare aggressively growing tumour, having a bright green colour, and showing an especial predilection for the bones

[1] *Roy. Lond. Ophth. Hosp.* (*Moorfields*) *Reports*, 1912, xviii., 153.
[2] *Trans. Ophth. Soc. U.K.*, 1890, x., 157.
[3] Meller, *Archiv. f. Ophth.*, 1906, lxii., 130.
[4] *Klin. Monats. f. Augen.*, 1869, vii., 312.
[5] *Archiv. f. Ophth.*, 1895, xli., 99.
[6] *Trans. Ophth. Soc. U.K.*, 1905, xxv., 181.
[7] *Trans. Coll. Physic., Philadelphia*, 1893, xv., 103.
[8] *Traités des Tumeurs de l'Oeil*, 1904, ii., 466.
[9] *Loc. cit.*
[10] *Klin. Monats. f. Augen.*, 1906, xliv., 328.
[11] *Loc. cit.*

of the skull and dura mater; dissemination in the viscera occurs, but the nervous system is rarely involved.

There is a difference of opinion in regard to the exact pathology of the condition. Some authorities regard the disease as essentially a leukæmia with secondary malignant tumours; others regard it as a malignant disease of bone marrow with secondary changes in the blood, these changes being in the direction of a lymphæmia or more rarely of a myelæmia.

There are greenish thickenings of the skull bones, especially of the frontal bones, so that proptosis is usually a marked feature—thirty-one out of forty-two cases (Pfeiffer); the dura mater becomes infiltrated in a patchy manner by the greenish tissue, which likewise protrudes into the lumen of the venous sinuses in which greenish clots may be found.

This green colour tends to bleach in museum specimens, but may be preserved for years if they are protected from the light.[1]

Affections of hearing and discharge from the ears are common.

Hudson and Coats [2] report a case very fully, and Dudgeon, who examined it pathologically, says the tissues are infiltrated with myelocytes as seen in the tissues and blood in leukæmia.

Türk reported a case in which green deposits were scattered in the periosteum of the lumbar vertebræ, and in which 47 per cent. of the white cells in the blood were myelocytes.

The close association of chloroma with leukæmia also receives the support of Fabian,[3] Lehndorff, Frith and Ledingham.[4]

The question is well reviewed by Hall, Hebb, and Bernstein.[5]

Hudson summarises thus: "in some cases, at any rate . . . cells which are normally almost confined to the bone marrow, and which have an important relation to the white cells of the blood, can be shown to form the most prominent constituents of the infiltration, a fact which suggests that such cases at any rate, must be regarded as examples of a disease arising primarily in the myelogenous component of the hæmatopoietic system."

[1] St. Bartholomew's Hospital Museum No. 437c.
[2] *Roy. Lond. Ophth. Hosp. Reports*, 1912, xviii., 181.
[3] *Beit. z. path. Anat. u. z. allg. Path.*, 1908, xliii., 172.
[4] *Pro. Roy. Soc. Med.*, Path. Sect., 1910, iv., 60.
[5] *Pro. Roy. Soc. Med.*, Med. Sect., 1909, ii., 157.

Gallemaerts [1] reports a case in which dissemination took place into the retina and choroid of one eye, amongst many other tissues.

CHLOROSIS.

A considerable number of cases of pathological change in the eye fundus have been reported in this fast disappearing disease, but whilst chlorotic subjects are, of course, not immune from other conditions which cause papillœdema, it may be urged that particular care is needed before papillœdema occurring in a chlorotic subject is attributed to the blood condition. Nevertheless, in a number of cases the changes are reported to have disappeared, and the vision to have been restored under treatment by iron, and the subsequent progress of the patient has confirmed the causal relationship of the two conditions.

On the other hand a number of the reported cases are not convincing, either as to the presence of the fundus changes, or as to the exclusion of causes in addition to the chlorosis, and the occurrence of pseudo-papillœdema requires especially to be had in mind.

The change which is most often described is a simple papillœdema, but in some cases a star figure at the macula and hæmorrhages have been described; as has been pointed out, retinal hæmorrhages may be seen in any severe anæmia, and have no special significance. By Pagenstecher the occurrence of the disc change is attributed to a supposed increase of the intracranial pressure.

The combination of disc changes with some of the concomitant symptoms of chlorosis, headache and perhaps vomiting, may closely counterfeit a cerebral tumour.[2]

[1] *Klin. Monats. f. Aug.*, 1914, lii., 878.

[2] The following are references to a few of the reported cases and literature: Ballaban, *Archiv. f. Aug.*, xli., 281; Cushing and Bordley, *Amer. Jour. of Med. Scien.*, 1908; Bannister, *Jour. of Nerv. and Men. Dis.*, N. York, xxv., 874; Bitsch., *Klin. Monats. f. Aug.*, xvii., 144; Gowers, *Brit. Med. Jour.*, 1881, i., 797; Kingborn, *Montreal Med. Jour.*, 1900, 42; Litten and Hirschberg, *Brit. Med. Jour.*, 1885, i., 328; Westcott and Pusey, *Archives of Ophth.*, 1902, 23; Posey, *Trans. Amer. Ophth. Soc.*, xii., 284.

FUNDUS CHANGES IN SECONDARY ANÆMIAS.

It is common to find changes in the eye fundus in patients who are severely anæmic from any cause, whether from loss of blood or as a part of a severe emaciation or cachexia.

Thus I examined a heterogeneous group of forty-three patients in St. Bartholomew's Hospital, ill of different serious diseases, all of whom were markedly anæmic, with a view to discovering the frequency of these changes.

The average number of red blood cells was 2,336,000, and the average hæmoglobin percentage 35·3.

Amongst them, gastric or duodenal ulcer, whether innocent or malignant, formed the greatest number, but other diseases represented were hæmophilia, hæmorrhoids, enteric, epistaxis, intestinal hæmorrhage, etc.

Some of the changes have reference only to the local expression of the bloodlessness, others are more discrete and conspicuous.

Amongst the former group are :—

(1) A general pallor of the fundus, as of the cheeks.
(2) The blood within the retinal vessels may be clearly lacking in colour as if it had been diluted, and consequently there is less difference than is normal between the colour of the arteries and the veins.
(3) The retinal vessels are well filled, and indeed, in spite of the general bloodlessness, it is not rare for them to appear somewhat distended.
(4) In severe cases there is often the appearance of a faint general haze over the whole fundus which is most noticeable over the disc ; it is somewhat as if the surface had been covered with a wash of milky water.

The more conspicuous changes consist in the presence of retinal hæmorrhages and white patches.

Amongst the forty-three patients referred to, ten had hæmorrhages alone, two had white patches alone, and in four both hæmorrhages and white patches were present.

The hæmorrhages are seldom if ever profuse, and in many

cases two or three only are present; they are usually in the nerve fibre layer and close to the disc; they give rise to no symptoms and disappear leaving no residue.

Their incidence is not in direct relationship with the degree of anæmia:—I have examined a small boy, a hæmophilic, who bled to death from biting his tongue when cracking a nut, but no hæmorrhages were present—six brothers had all bled to death from trivial causes; another hæmophilic had 1,200,000 red corpuscles and 18 per cent. of hæmoglobin, but his retina was free of hæmorrhages, so also was the retina of a girl who had only 520,000 red blood cells and 18 per cent. of hæmoglobin.

Of special interest are the soft-edged white patches, which individually, are quite indistinguishable as seen with the ophthalmoscope, from the "cotton wool patches" of renal retinitis.

They were present in six of the forty-three cases, in two by themselves, and in four in association with hæmorrhages.

They are situated in the nerve fibre layer, for they sometimes partly obscure a retinal vessel.

What is their histological counterpart I am unable to say; perhaps they represent patches of gangliform degeneration in the nerve fibre layer.

When these patches and retinal hæmorrhages occur together, the ophthalmoscopic picture cannot be distinguished from that which is occasionally seen in early cases of renal retinitis.

The white areas, like hæmorrhages, disappear and leave not the slightest trace behind; the shortest time in which I have observed one to fade away is fifteen days.

PURPURA.

Hæmorrhages into the retinal tissues are not rare in this disease, they are most commonly situated in the nerve fibre layer and not far from the disc.

They do not carry any particular prognostic significance, and run the course of similar hæmorrhages in other similar conditions, *e.g.*, the secondary anæmias, etc.

RAYNAUD'S DISEASE.

A few observers have described spasm of the retinal vessels in this disease.

On a number of occasions I have examined specifically for this condition, but in no case was there any evidence of its presence at the time of examination, and this is in accord with the findings of Blaauw,[1] who made a careful investigation of this point.

Batten [2] reports retinal hæmorrhages in a woman who had suffered from the disease for eleven years, and in whom two toes had become gangrenous.

SERIOUS LOSS OF SIGHT RESULTING FROM LOSS OF BLOOD.

It is common for patients who are actually dying from loss of blood to say that everything is black before them, but apart from this, large hæmorrhages result in some cases of those who recover, in serious or complete permanent loss of sight in one or both eyes.

By a long way the commonest cause is bleeding from the intestinal tract, and next most frequently uterine hæmorrhage; it is quite unusual for it to occur as the result of traumatic hæmorrhage.

During the late war, in spite of the very numerous cases of profuse bleeding, I did not see any such case, nor have I been able to hear of any, and Grout [3] states on the authority of De Wecker, Kneis and Wilbrand and Saenger, that in the Franco-Prussian War no case was seen where visual disturbances could be attributed to surgical hæmorrhage alone. Carlini,[4] however, reports a case from severance of the radial artery whilst wood chopping.

Chevallereau [5] collected twenty-one cases resulting from

[1] *Sammlung zwangloser Abhandlungen aus dem Gebiete der Augenheilkunde*, 1913, ix., 5.
[2] *Trans. Ophth. Soc. U.K.*, 1910, xxx., 238.
[3] *Archiv. of Ophth.*, 1914, xliii., 234.
[4] *La Clinica Oculist.*, 1906, 2353.
[5] *Archiv. d'Ophth.*, 1903, 417.

uterine hæmorrhage, of which nine were confinements at term and ten were cases of abortion.

The onset of blindness may be immediate or it may be delayed, and the two eyes are by no means necessarily equally or simultaneously affected.

Thus, Fries [1] analysed ninety-six cases, and found that in 25 per cent. there was immediate loss, and in 23 per cent. the onset was delayed for periods up to eighteen days or longer.

Of his cases there was complete and permanent loss of sight in both eyes in 65 per cent., and in 10 per cent. one eye alone was affected; of Chevallereau's cases eight were chiefly unilateral.

It is notable, too, that when both eyes are affected there is often an interval of days between the dates of their involvement.

Although the usual history is of a large sudden loss of blood, sometimes a prolonged drain, *e.g.*, from hæmorrhoids, may produce it.[2]

Complete recovery of vision does not occur: a man who had had bleeding piles for ten years suddenly went nearly blind; his red blood cells numbered 4,000,000 per c.m., and his hæmoglobin was 35 per cent.; five weeks after operation for his piles these figures were 6,200,000 and 105 respectively; his plethoric appearance was in striking contrast to his previous flabby, chlorotic aspect; his vision, however, did not improve.[3]

Some improvement, nevertheless, is not rare. Swect [4] reports such a case.

On ophthalmoscopic examination in the early stage there is slight œdema of the disc, the vessels are pale, but of full size, and in a few cases a small hæmorrhage or two have been present; later on atrophy becomes established, the disc becomes paler, and the vessels become permanently reduced in size.

Ulrich [5] and Hoffmann [6] examined the retina immediately after the occurrence of a large hæmorrhage.

[1] Quoted Gowers' "Med. Ophth.," 1904, 225.
[2] Foster Moore, *St. Bartholomew's Hospital Reports*, 1910, xlvi., 181; *Trans. Ophth. Soc. U.K.*, 1911, xxxi., 39.
[3] Foster Moore, *ibid.*
[4] *Trans. Amer. Ophth. Soc.*, 1903, x., 183.
[5] v. Graefe's *Archiv. f. Ophth.*, 1887, xxxiii., ii., 1.
[6] *Klin. Monats. f. Augenheilk.*, 1883, 171.

The patient, a woman of twenty-five, had had a hæmatemesis from a gastric ulcer; the fundi were pale but were otherwise normal.

Two days later a fresh bleeding took place and the retinæ were examined ten minutes later.

The discs were extremely pale and sharply outlined, the arteries were narrow and difficult to follow to the periphery, the veins were somewhat distended, but at the disc edge they suddenly lost their dark red colour, and from there as far as could be seen outwards they became a bright red as if the veins were continued into arteries.

It would seem clear that the severe local anæmia hereby implied might well result in permanent damage to the retina.

The approximation in colour between the arteries and veins is common in severe anæmia.

ERYTHRÆMIA (VAQUEZ'S DISEASE).

This disease was first defined by Vaquez [1] in 1892. Its features are :—

(1) The presence of erythræmia for which no cause—*e.g.*, congenital heart disease, chronic bronchitis and emphysema—can be found. The number of red cells is usually between seven and twelve millions, the cells being of normal appearance. The hæmoglobin is seldom increased in proportion to the number of cells, hence the colour index is low. There is a moderate degree of leucocytosis, from 10,000 to 30,000.[2]

(2) A florid cyanotic appearance.

(3) Enlargement of the spleen and liver.

The disease usually occurs in adults between the ages of thirty and sixty, and is rather more frequent in males.

It is probably due to a primary hyperplasia of the erythroblastic tissue of the bone marrow.[3]

Defects or abnormalities of vision are often complained of, and marked ophthalmoscopic changes are frequently present. It is, however, clearly shown by a number of observers, that

[1] *Bulletin Med.*, 1892, vi., 849.
[2] Parkinson, John, *Lancet*, 1912, 1425.
[3] Parkes Weber, *Quart. Jour. of Med.*, 1908, ii., 85.

there may be a very serious disturbance of vision, approaching to complete blindness, with almost no ophthalmoscopic changes.

Thus Friedenwald [1] calls particular attention to the visual disturbances which sometimes are accompanied by fundus lesions, but at other times occur independently, or in association with ophthalmoscopic changes which are quite inadequate to explain them.

Osler [2] reports a case of "failing vision, the condition of the fundus being negative with the exception of tortuosity of the

FIG. 27.—A section through the retina, choroid, and part of the sclerotic to show the great engorgement of the choroid with blood in a case of erythræmia (Vaquez's disease). From a man, a patient of Dr. J. H. Drysdale, who had had symptoms for seven months. The chief ophthalmoscopic sign was a great engorgement of the retinal veins. At one time his blood count was as follows: Red blood cells, 12,580,000; hæmoglobin, 148 per cent.; colour index, 0·74; white blood cells, 25,000. *A.* Retina. *B.* Choroid. *C.* Sclerotic.

vessels," and Lucas [3] a case who became quite blind although nothing was found in the optic discs beyond slight hyperæmia.

I have seen a woman who was all but blind in one eye, and had greatly reduced vision in the other, with disc changes which would not have suggested nearly so great a loss of sight.

Of little importance is the congestion of the conjunctival vessels which gives the eye a bloodshot appearance and so simulates conjunctivitis.

[1] "Contributions to Med. and Biolog. Research," 1919, i., 495.
[2] *Amer. Jour. Med. Sci.*, 1903, cxxvi., 187.
[3] *Archiv. Int. Med.*, 1912, x., 597.

The abnormalities of sight are numerous, varied, and are often indefinite.

Lucas [1] found some disturbance of vision in thirteen out of forty cases, and Christian [2] describes ten cases, in eight of which there were indefinite visual disturbances.

The symptoms complained of are such as flashes of light, photophobia, sparks, blurring or general mistiness of vision (John Parkinson), whirling objects, black spots, scotomata, hemianopia, diplopia, etc.

Friedenwald reports a case in which visual symptoms preceded all other signs of the disease by several years.

Ophthalmoscopic changes are frequently present, and may be extreme in degree ; I have notes of four cases in which they were well marked ; other cases are reported by Jackson,[3] Parker,[4] Jackson,[5] Dupuy-Dutemps and Lutembacher,[6] Hutchinson and Miller,[7] Osler,[8] Englebach and Brown [9] and Watson.[10] In three of my own cases there was marked or extreme engorgement of the retinal veins with hæmorrhages, the arteries being of normal size, and in one of them the condition simulated thrombosis of the central retinal vein so closely, that one was led to suggest, that prominent cerebral symptoms which were present, might be due to thrombosis of the cranial sinuses, as indeed proved to be the case at the autopsy.

In one of the cases the disc changes differed little from the papillœdema of a cerebral tumour.

CYANOSIS RETINÆ.

In some cases of congenital heart disease abnormal retinal appearances are seen.

Posey [11] collected eighteen cases.

[1] *Archiv. Int. Med.*, 1912, x., 597.
[2] *Amer. Jour. of Med. Sci.*, 1917, cliv., 547.
[3] "*Ophthalmology*," 1907, iv., i.
[4] *Trans. Amer. Ophth. Soc.*, 1909—11, xii., 505.
[5] *Trans. Amer. Ophth. Soc.*, 1906—8, xi., 363.
[6] *Annal. d'Ocul.*, 1912, cxlviii., 81.
[7] *Lancet*, 1906, i., 744.
[8] *Amer. Jour. Med. Sci.*, 1903, cxxvi., 187.
[9] *Jour. Amer. Med. Assoc.*, 1906, xlvii., 1265.
[10] *Liverpool Med. Chir. Jour.*, 1906, xxvi., 33.
[11] *Trans. Amer. Ophth. Soc.*, 1903—6, x., 634.

The conjunctival and anterior ciliary veins are distended, the retinal vessels, both arteries and veins, are darker than normal, the arteries being about the colour of normal veins, and the veins are of a much darker hue.

At times engorgement of the vessels involves both sets of vessels, whereas in other instances the size of the arteries is not altered ; retinal hæmorrhages are not infrequent.

Nagel [1] states that if both arteries and veins are broader and darker than normal, the presence of a communication between the two sides of the heart is assured, whereas if the darker coloration and tortuosity are limited to the veins, some other lesion exists which does not allow of the mixing of venous and arterial blood.

As compared with the retinal changes in Vaquez's disease, to which there is a considerable similarity, retinal hæmorrhages may be very profuse in the latter and are never profuse in cyanosis retinæ.

The arteries are but little changed either in size or colour in Vaquez's disease, and the veins do not attain so deep a colour as in cyanosis.

RETINAL HÆMORRHAGES IN NEW-BORN INFANTS.

Retinal hæmorrhages are of common occurrence in new born infants, and are presumably developed during the process of birth.

Coborn [2] examined histologically the eyes of thirty-seven infants, the oldest of whom had lived twenty-two days ; seventeen of them had hæmorrhages in the retina, especially in its inner layers ; they have also been examined histologically by v. Hippel.[3]

De Vries [4] examined 112 infants ophthalmoscopically, and found hæmorrhages in 11 per cent., and Königstein [5] found

[1] Quoted by Posey, *Trans. Amer. Ophth. Soc.*, 1906, x., 636.
[2] *Archives of Ophth*, xxxiii., 3, 256.
[3] v. Graefe's *Archiv., f. Ophth.*, 1898, xlv., 313.
[4] *Ned. Tydschr. d. Geneesk*, 1901, i., 6.
[5] *Mediz. Jahrbücher Wien*, 1881, 47—70.

twenty-nine cases of retinal hæmorrhages amongst 281 infants, *i.e.*, about 10 per cent.

Naumhoff found the percentage as high as 25. (See also p. 188.)

THROMBOSIS OF RETINAL VEINS.

Thrombosis may take place in the central retinal vein itself, and then usually occurs, as shown by Coats,[1] within or at no

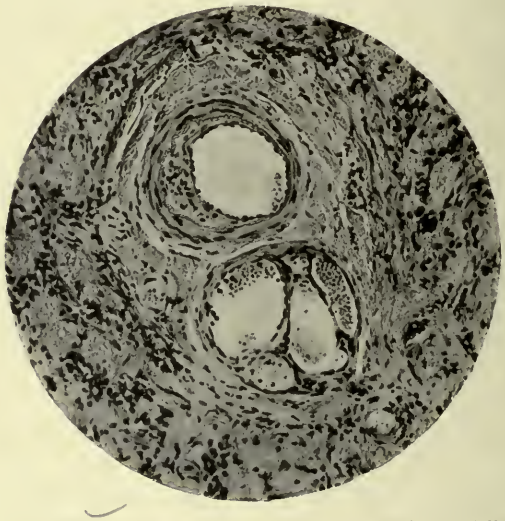


Fig. 28.—Complete canalisation of the central retinal vein following its thrombosis. (Coats.)

great distance from the lamina cribrosa, or it may occur in one of the tributaries of the vein as it courses in the retina, and in this case its site may be determined by the presence of a sclerosed artery crossing it.

Its occurrence is signalised by a rather rapid loss of sight, but this is by no means so sudden nor is it nearly so complete as in sudden obstruction to the arterial flow.

For a full and excellent account of the pathology of the condition, the articles by Coats should be consulted.

[1] v. Graefe's *Archiv. f. Ophth.*, 1913, lxxxvi., 341; *Roy. Lond. Ophth. Hosp. (Moorfields) Reports*, 1906, xvi., 65.

Frequency.—Within twelve months I was able to collect sixty-one cases of this condition at the Moorfields Eye Hospital. These were under the care of the twelve surgeons there, and many of them had been attending at intervals for a number of years; this number, therefore, does not represent one year's supply, but shows that during one year more than sixty-one individuals who were the subject of this complaint attended at the institution.

These sixty-one individuals I examined at regular intervals as to their blood pressure, the urine, visual fields, visual acuity, and intra-ocular pressure, and in more than half of them I traced by means of pencil drawings some of the minute changes which occurred in the veins themselves, in the hæmorrhages, the exudates and the discs.

Age and Sex.—In most cases the patients are past middle age, the average for fifty-nine of them being—males sixty, females sixty-two—and six only were younger than fifty years. The average age of Coats' patients was 60·8 years, the oldest being eighty-five, and the youngest thirty. The sexes are equally liable, for thirty-one were males and thirty females; of Coats' cases, however, twenty-five were males and eleven females.

Causation.—In a great majority of the cases the immediate cause of the thrombosis is angio-sclerosis, and as has been remarked, the immediate exciting cause in some cases of tributary thrombosis appears to be the pressure of a thickened artery acting upon a vein whose walls are already diseased.

One need only remember the changes which are readily visible in the veins at the arterio-venous crossings in many cases of arterio-sclerosis (Fig. 19), to feel no surprise that thrombosis of the vein should here occur.

The evidence of arterio-sclerosis is generally conspicuous to ophthalmoscopic examination.

In addition, the systolic blood pressure in forty of the sixty-one patients in whom it was taken at intervals, was on an average 187 mm., in eleven only was it less than 160.

Urine.—In fifteen out of fifty patients, albumen, usually in small amount, was found in the urine, and I suspect that had more frequent examinations been made, the proportion would

have been increased, for in a number of them a single examination only was made; in many, however, repeated investigations at intervals gave a negative result.

In one only was sugar present.

Ophthalmoscopic Appearances.—The veins in this condition are greatly engorged, turgid and tortuous; they are dark in colour, and profuse hæmorrhages into the retina are present in the whole of the territory drained by them.

Thus, if a tributary only is thrombosed, the territory of the retina drained by it is profusely spattered with hæmorrhages, whilst the rest of the retina is clear, the whole retina is covered with hæmorrhages when the central vein itself is involved.

The hæmorrhages are for the most part in the nerve fibre layer, are largest in the central regions, and are not infrequently fringed by white exudate.

In the course of time they completely disappear, and may leave no sort of trace behind of their former existence, though pigmentary changes of a fine texture are not rare, especially at the macula region.

The fundus appearances in some cases of Vaquez's disease, simulate very closely the ophthalmoscopic appearances of thrombosis of the central retinal vein.

Of the present sixty-one patients, thrombosis of a tributary occurred in twenty-eight, and in thirty-three the main vein was blocked.

As is to be expected, the progress of the changes are more severe, and the complications more marked, in cases where the main vein is involved.

The Visual Fields.—The fields of vision show less change than might well be expected.

In the case of thrombosis of the central vein there is concentric contraction of the field, though not to a great extent, sometimes there are, in addition, irregular defects for which there is no obvious explanation, but most important is the almost constant presence in these cases of a central or a paracentral scotoma, which is responsible for the great fall in visual acuity. Sometimes this scotoma is partial only, and requires investigation with low illumination for its discovery (Fig. 31).

When a branch of one of the retinal arteries is suddenly obstructed, there is immediately developed a corresponding sector defect in the field of vision; when, however, a tributary of the vein is blocked, no such sector is produced, though some concentric constriction may occur, and besides, unless the blocked vein is directly concerned with the macula area, no central scotoma occurs and the visual acuity is not spoiled.

Progress.—As already stated, the central visual acuity where the main vein is concerned, is usually much reduced, owing to the presence of a central scotoma, and whilst in some cases the general condition of the retina improves, and in a few cases good sight is restored, as a rule no improvement of vision occurs, but on the contrary, there is a further slow deterioration till no useful vision remains.

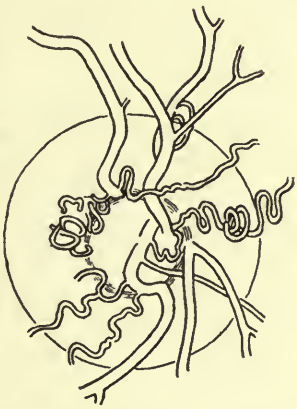


FIG. 29.—To show the formation of new collateral veins on the disc in a man of sixty-two, in whom thrombosis of the central retinal vein had occurred thirteen months previously. His systolic blood pressure was 180 mm.

In tributary cases the loss of vision is much less from the first, and many cases have and retain good or normal central acuity.

Many cases of central vein thrombosis develop acute glaucoma in the course of a few weeks and so sight is lost, but otherwise in many a slow degeneration from chronic glaucoma occurs, the disc becoming deeply excavated; this does not happen in cases where a tributary only is thrombosed.

The average interval between the thrombosis and the onset of glaucoma was 100 days,[1] or 9·07 weeks (Coats), eighteen out of twenty occurred within fifteen weeks, the longest interval being forty weeks (Coats).

In many recovered cases bunches of tortuous veins are developed on the discs, the result of the development of collateral channels (Fig. 29) between the choroidal and retinal

[1] Inouye, *Royal Lond. Ophth. Hosp. Reports*, 1910, xviii., 33.

systems; in other cases circulation is restored by canalisation of the clot as shown by Coats (Fig. 28).

In tributary cases it is very interesting to watch the gradual formation of a new vessel, always exceedingly tortuous, to connect the distal with the proximal portion of the vein, the actual thrombosed part being transformed into a fibrous cord (Fig. 32), but in addition, extensive development of new venous channels, or perhaps dilatation of existing capillary

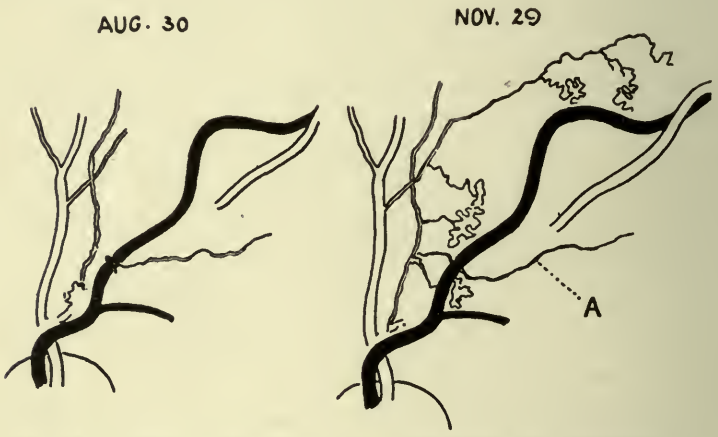


FIG. 30.—A case of thrombosis of the upper temporal vein of the left eye in a woman aged fifty-nine, whose systolic blood pressure was 155 mm. Eight and a half years later she was in good health; she described the left eye as being weaker than the other, a blot being over the inner side. The first drawing was made five months after the occurrence of symptoms and the second one three months later. Notice the throwing out of tortuous venules, apparently in an endeavour to establish a collateral circulation. See also Fig. 31.

connections occurs, so that neighbouring veins become connected by fine, very tortuous vessels, the useful function of which is not always clear.

In other cases these vessels appear to begin to develop, and after extending for considerable distances they seem to end blindly, having apparently failed to meet with a reciprocal communicating vessel from a neighbouring vein (Fig. 30).

The prognosis as to life is dependent upon the general condition of the patient and is not varied by the accidental occurrence of thrombosis of the ocular vein.

I have had patients under observation and in good health, one for twenty-one years and one for fifteen years after the occurrence of thrombosis, and many others I have watched in reasonable health for many years.

It is not common for a patient to develop venous thrombosis in each eye, even though the factors conducive to its occurrence are almost necessarily bilateral. I have, however, seen it occur

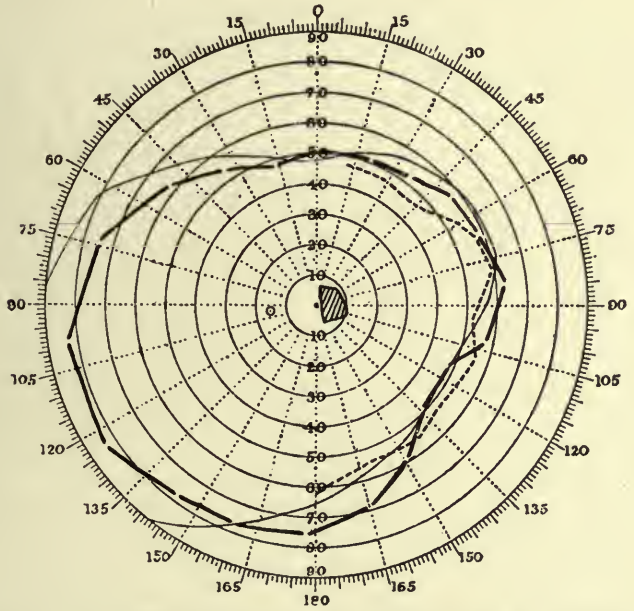


FIG. 31.—The visual field of the eye from which Fig. 30 was drawn. The continuous line represents the field taken with a 10 mm. white square in full daylight; the dotted line represents the field taken with a 5 mm. white square in a semi-darkened room. Note the paracentral scotoma, and that there is no sector defect of field to correspond with the thrombosed vein.

on five occasions, and short of it, hæmorrhages in the retina of the other eye are common.

On several occasions I have found, on examining the "good eye," that innumerable minute hæmorrhages were present towards the periphery in the region of the small venous radicles, looking likes leaves on the branches of a tree, the branch being represented by the smaller veins and their tributaries.

It seems likely in such a case that partial obstruction exists as in cases reported by Coats,[1] and that perhaps a collateral circulation is established.

I have seen one such case in which seven years later, only an odd hæmorrhage or two were present, and the vision was 6/6; no further advance of the disease had occurred.

Fig. 32.—To show the formation of new collateral venous channels in the retina consequent upon thrombosis of a tributary of the vein. From a man aged eighty-four, who nineteen years previously had attended the Moorfields Eye Hospital on account of thrombosis of the vein. *A*. Thrombosed vein converted into a fibrous cord.

It will be seen that a very great majority of the cases under consideration occur in folk past middle age, and are directly referable to disease of the vessels; in a few instances, however, the condition occurs in young subjects without any evidence of vascular disease, and in whom there is a history of some recent febrile disorder.

It has been shown by Coats that in such cases the veins show evidence of an acute phlebitis, and it is at times difficult to avoid the conclusion, that infection of the vein wall is the immediate cause of the clotting. It is clear that such an occurrence has no prognostic significance as regards the future health of the individual.

THROMBOSIS OF THE CAVERNOUS SINUS.

The causes of thrombosis of the cavernous sinus are of three kinds:—

(1) Infective.
(2) Primary or marasmic.
(3) Traumatic.

[1] *Roy. Lond. Ophth. Hosp. Reports.*, xvi., 81.

The changes in the eyes which are referable to its development may be divided into two groups :—

(1) Those due to obstruction of the venous circulation.
(2) Those due to nerve involvement.

(1) A varying degree of proptosis is of constant occurrence, and is due to venous obstruction and œdema of the orbital cellular tissues. The proptosis commences on one side, but afterwards spreads to the opposite side, from extension of the thrombosis by means of the circular sinus.

This is a point of importance in distinguishing the condition from orbital cellulitis, which it may simulate closely, and with which it may be associated.

Chemosis and œdema of the lids is common. Changes in the eye fundus are by no means constant ; a number of cases are reported in which œdema of the retina, swelling of the disc, and tortuous veins have been present ; on the other hand, the fundi are frequently free of any marked abnormality.

It was shown by Wadsworth and Putman that no certain change was observable in the retinal veins, when an extreme degree of vascular congestion was produced by tying a handkerchief round the neck.

Coupland [1] suggests that when retinal changes are present they imply that the thrombotic process has spread to the facial or ophthalmic veins.

(2) All the ocular nerves are apt to be involved as they traverse the cavernous sinus, producing supra-orbital neuralgia, ptosis, and ophthalmoplegia interna and externa.

This is especially true of infective cases, and occurs also in orbital cellulitis. It is a point which may be of considerable importance in distinguishing one or other of these conditions, from the proptosis due to a neoplasm or Graves' disease.

In non-infective cases the function of the nerves is often spared.

Frequency.—Coupland collected twenty-eight cases, in twenty-three of which a post-mortem examination was made.

[1] *Trans. Ophth. Soc. U.K.*, 1887, vii., 240.

Fourteen were of infective origin, and seven of these were due to otitis media.

Four were traumatic, and five were included under the heads of marasmus, cachetic, or primary.

Jackson [1] added twenty-eight cases to 182 collected by Dwight and Germain, and showed that of these 210 cases, 20 per cent. were secondary to infection in the region of the face.

[1] "*Ophthalmology*," 1909, v., 185.

CHAPTER III

Disturbances of visual orientation—Lesions of the sympathetic nerve—Hysteria—Epilepsy—Ophthalmoplegia externa—Ophthalmoplegia interna of unknown cause—Hydrocephalus—Encephalitis lethargica—Polio-encephalitis—The intra-ocular lesions in tabes and general paralysis—Friedreich's ataxia—Acute myelitis with retro-bulbar neuritis—Disseminate sclerosis—Syringomyelia—Myasthenia gravis—Myotonia atrophica.

DISTURBANCES OF VISUAL ORIENTATION.

Lesions of certain parts of the brain have, as a prominent manifestation, great disturbance of visual orientation, and whilst these have been noted previously, it is only as a result of the investigation of wounds of the brain in the late war chiefly by Gordon Holmes [1] and Holmes and Horrax [2] that the localisation of the lesion has been identified, and the clinical signs defined.

Seven of such cases were studied minutely. The following were the chief manifestations of the defect.

The patient was unable to touch accurately an object within his sight and reach, and in attempting to do so he made mistakes in all three dimensions of space: he would collide with easily seen objects; if, however, he was allowed to touch them he would easily evade them.

The absolute and relative size and position of two objects simultaneously in the visual field were not accurately judged.

Such men, too, show a difficulty in exploring a limited surface with their eyes; thus they are unable to count the number of coins placed on a table, and for this same reason reading is difficult.

In a few cases stereoscopic vision seems to be destroyed.[3]

There is a difficulty in the fixation of objects seen; this is a natural result of the fact that the position of an object throwing

[1] *Brit. Jour. of Ophth.*, 1918, ii., 449 and 506.
[2] *Archiv. of Neurol. and Psych.*, 1919, i., 385.
[3] Riddoch, *Brain*, 1917, xl., 45.

an image on the retina is not correctly appreciated, and consequently the eyeballs cannot be so rotated as to bring the exciting image to the macula.

Site of the Cerebral Lesion.—In two cases, Gordon Holmes was able to examine the brains post-mortem; in the other cases the site of the damage was estimated by craniometric measurements.

He believes, that in order to produce this symptom complex, the lesion must involve that part of the lateral surface of the hemisphere which includes the angular and supra-marginal gyri, and extends into the adjoining occipital, temporal, and parietal convolutions, and that the lesion must be a bilateral one.

The wounds on the mesial surface of the hemisphere probably all lay in the region of the splenium. In several cases there were defects of the visual fields due to damage to the optic radiations.

For several reasons it seems clear that the symptoms are due to the damage to the cortex on the lateral surface of the hemisphere, or to the subjacent fibre system, and not to the lesion on the mesial surface, for a few cases showing these clinical manifestations have been recorded, which were due to vascular lesions in this region on both sides, but without damage to the mesial surfaces; and further, certain manifestations, which were almost undoubtedly due to defects of visual orientation, were observed in monkeys after the removal of corresponding cortical areas on both sides, by Monk, and Ferrier and Schäfer, without interference with the mesial aspect of the hemisphere.

LESIONS OF THE SYMPATHETIC NERVE.

The nerve fibres which control the dilator pupillæ are believed by some to commence their course in the medulla, and by others to start from a cilio-spinal centre in the cervical cord. Karplus and Kreidl,[1] however, as a result of experimental work, seem to have established the existence of an important sympathetic centre in the hypothalamic region.

[1] *Arch. f. d. ges. Physiol.*, 1909, cxxix., 138; cxxxv., 401, and cxliii., 109.

From this centre fibres go to both sympathetic nerves, but especially to the contra-lateral one, and Spiller [1] believes on clinical grounds that in man the decussation takes place above the pons.

The fibres leave the spinal cord by the anterior roots of probably the last cervical and first two dorsal nerves, although the exact roots are still in dispute [2]; they reach the corresponding sympathetic ganglia by means of the white rami communicantes, and continue in the sympathetic chain as preganglionic fibres, to the superior cervical sympathetic ganglion.

In this ganglion synapses are formed with ganglion cells from which the post-ganglionic fibres arise.

These fibres are continued into the skull with the internal carotid artery, and joining the medial branches of the internal carotid nerve, connect up with the cavernous plexus, from whence they join the ophthalmic division of the trigeminus, and by the naso-ciliary and long ciliary nerves reach the pupil.

It is presumed that a lesion of the fibres may occur in any part of their course, and may be of an irritative or paralytic nature; the latter is much the more frequent, and it is probable that the irritative lesions ultimately pass into the paralytic stage.

Cases have been reported in which symptoms of irritation of the nerve have occurred with *paralysis* of the limbs.[3]

Condition of the Pupil.—With paralysis of the nerve the pupil is smaller than normal; it is still further constricted by light stimulus and by eserine, and is dilated by atropine.

Instillation of adrenalin, ordinarily inactive in causing dilatation of the pupil, becomes exceedingly active when the sympathetic is cut, or the superior ganglion removed.[4]

The pupil fails to dilate with cocaine, consequently the instillation of this drug in a 5 per cent. solution to each eye,

[1] *Amer. Jour. of Med. Scien.*, 1920, clix., 325.
[2] Buzzard, *Brain*, 1902, xxv., 308; Bramwell, *Rev. Neurol. and Psychiat.*, 1903, i., 236.
[3] Lloyd, "Twentieth Century Practice of Med.," 1897, xi., 457.
[4] de Schweinitz, *Jour. Amer. Med. Ass.*, 1904, xlii., 286.

and comparison of the pupils at the end of a quarter of an hour, becomes a convenient test for sympathetic paralysis.

Parsons and Henderson showed that in animals, this effect was immediate and persisted indefinitely (two years).

Mayou [1] and Bistis [2] have each reported cases of sympathetic paralysis, in which the iris on the affected side was blue or grey, the opposite one being brown, there being no other cause for this abnormality.

The size of the affected pupil is about what it would normally be in a good light, and so the abnormality is apt to be overlooked; the disparity in size of the two pupils, however, at once becomes obvious in dull illumination.

The symptoms of *irritation* of the nerve are :—

(1) Mydriasis due to spasm of the dilator pupillæ.
(2) Widening of the palpebral fissure due to contraction of unstriped muscle tissue in the upper lid.
(3) Constriction of the vessels of the face and neck and increase of perspiration.
(4) And perhaps exophthalmos, which is said to be due to the contraction of unstriped muscle tissue in the orbit (Müller's muscle).

The paralytic symptoms are the converse of the above. There is a tendency for some of these manifestations to be recovered from in part as time proceeds, but it seems that the pupillary changes are permanent. Thus it was shown by Jessop [3] that removal of a piece of the sympathetic nerve was followed immediately by miosis, and Parsons and Henderson [4] showed that the above was true, whether the nerve was cut or the ganglion was removed; they showed further, by keeping the animal alive, that the condition of the pupil was unchanged at the end of two years.

Langley and Anderson [5] demonstrated that the sympathetic has no inhibitory power over the sphincter pupillæ.

[1] *Trans. Ophth. Soc.*, 1910, xxx., 196.
[2] *Arch. of Ophth.*, 1915, xliv., 433.
[3] *Pro. Roy. Soc.*, 1885, xxxviii., 432.
[4] *Ophth. Review*, xxvii., 325.
[5] *Jour. Physiol.*, 1892, xiii., 555.

They were unable to prove the existence of an actual dilator muscle of the iris as occurs in some animals. Langley says [1]: "The contractile substance probably consists, not of ordinary unstriped muscle, but of the processes of the cells covering the posterior surface of the iris."

Heese [2] states that the sympathetic has no control over accommodation.

Causes.—There is no known specific cause for paralysis of the sympathetic, but it seems it may be affected by any pathological process in any part of its course; amongst the causes are the following:—

Syringomyelia, or injuries to the spinal cord; thus Hutchinson [3] reports a case of partial division of the cord by a stab wound, with symptoms of sympathetic paralysis on the injured side in addition to the limb palsies; the patient survived for many years, the symptoms persisting.

Injuries of the roots of the brachial plexus; involvement in the thorax by growths, glands or aneurysms; cervical ribs [4]; aneurysms, growths or glands in the neck; simple goitres,[5] etc.

In addition, many cases occur in which there is no discoverable cause, or in which the only discoverable possible cause, *e.g.*, a small thyroid adenoma or slight enlargement of cervical glands, etc., seems to be inadequate; indeed the majority of cases come under this head.

Glaucoma.—A number of observers have found histological changes in the sympathetic ganglia in glaucoma, and this has led to resection of the nerve for the relief of this disease.

Changes were found by Fisch,[6] Ziehe and Axenfeld, Lodato,[7] and others.

It has, however, to be borne in mind that pathological changes are usually to be found in these ganglia in old people whatever the cause of death.

The point has been re-examined by Ira Van Giesen and

[1] Schäfer's "Text-book of Physiol.," 1900, ii., 617.
[2] Phlüger's *Archiv. f. Physiol.*, 1892, lii., 535.
[3] *Roy. Lond. Ophth. Hosp. Reports*, v., 139.
[4] Mayou, "*Ophthalmoscope*," 1916, xiv., 313.
[5] Langdon, *Trans. Amer. Ophth. Soc.*, 1916, xiv., 661.
[6] "Ninth Internat. Ophth. Congress, Utrecht, 1899," 544.
[7] *Arch. di Ottalm.*, viii., 358.

Weeks,[1] who examined seven ganglia from patients with glaucoma, and four other ganglia, to act as controls, were carried through all the processes parallel with the former.

They state: "We find, then, that as far as our methods of examination of hardened material go, the ganglia seem to be normal with the exception of an excess of pigment in the neurone cell bodies, and as to the significance of this, if it has any, we are entirely as yet in the dark.

"The result of the examinations does not positively preclude the existence of a lesion in the ganglia."

HYSTERIA.

The most important manifestations of hysteria as they affect the eye, are loss of visual acuity, and alterations in the visual fields; they are often included under the general term "hysterical amblyopia."

Cases occur in either sex, several cases being recorded in young boys, thus Harlan [2] and Galezowski have each seen it in a boy of eleven, and Moore [3] in a boy of fifteen.

Gunn [4] divides these cases into two classes:—

(1) Idiopathic, occurring usually in females.
(2) Traumatic, affecting the sexes equally, but occurring usually in adults.

Neuropathic tendencies are generally prominent in these patients.

The onset of symptoms is insidious in the idiopathic form, and diagnosis may be difficult.

In cases following trauma there may be a period of incubation as pointed out by Charcot.

The loss of sight is always of a high degree and is most often unilateral. There are no ophthalmoscopic changes, and whilst both Borel [5] and Harlan [6] report cases in which it is stated the

[1] *Trans. Amer. Ophth. Soc.*, 1902, ix., 455.
[2] *Trans. Amer. Ophth. Soc.*, 1888—90, v., 328.
[3] *Trans. Amer. Ophth. Soc.*, 1888—90, v., 84.
[4] *Brit. Med. Jour.*, 1902, ii., 1425.
[5] *Annal. d'Ocul.*, 1900, cxxiii., 5 and 241.
[6] *Trans. Amer. Ophth. Soc.*, 1888—90, v., 330.

pupil reactions were abolished, this is of such exceedingly rare occurrence as not to vitiate the statement that the pupil reactions are unchanged in hysteria.

Much stress has been laid upon the contraction of the visual fields, and especially upon the so-called spiral contraction which was believed to be characteristic, and due to fatigue. Hurst and Symns [1] have, however, cast grave doubt upon the nature of this sign, and have shown how it is produced; they point out that it is a product of the perimeter, and that if some less suggestive means be employed to examine the fields, no constriction will be found. They show further, that the field obtained is a narrowing spiral if the test object on the perimeter is carried from without in, and a widening spiral if the object is carried from within out; and also that a narrowing spiral may be obtained in one eye and a widening one in the other (Figs. 33 and 34), and that in repeating the examination, the eye which before produced the narrowing spiral may be made to produce a widening one, and *vice versâ*. They state "we have never seen patients with hysterical symptoms who spontaneously complained of disabilities resulting from a narrow field of vision, however closely they were cross-examined on the subject"; further, "we have examined numerous soldiers suffering from various war neuroses, some of whom were suffering from gross hysterical symptoms, and we have never found any restriction of their fields of vision until they were tested with the perimeter, but the perimeter invariably resulted in the suggestion of a narrowed field, however carefully it was used."

The fields for colour are less constricted than for white.[2]

Many cases are reported where the amblyopia has persisted for very long periods without change.

Thus Dupuy-Dutemps [3] reports the case of a man of thirty-eight who was struck in the face with a piece of cloth, and who went blind in the left eye immediately afterwards. Six and a half years later he was still quite blind in the eye; he did not flinch on suddenly approaching an object to the eye; patches

[1] *Brit. Jour. of Ophth.*, 1919, 18.
[2] Casey Wood, *Amer. Jour. of Med. Sci.*, 1899, cxvii., 42.
[3] *Société française d'opth.*, 1902, 457.

of cutaneous anæsthesia were present. He quotes a second case which persisted unchanged for a year and a half, the eyes being quite normal in every way. Harlan reports a case of ten years' duration.

For differential diagnosis, more particularly from retrobulbar neuritis, Gunn lays great stress on the dilatation of the pupil which immediately succeeds to constriction in this latter disease;

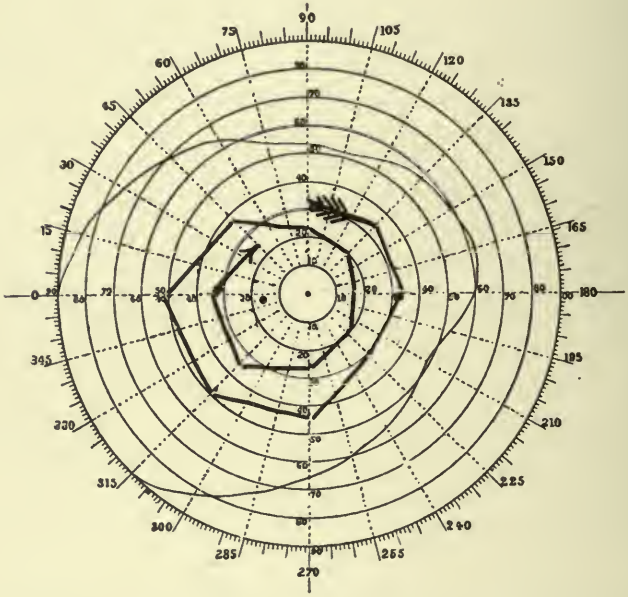


Fig. 33.—Spiral field of vision in a case of hysterical mutism and tremor. Without-inward spiral. (Hurst and Symns.)

he insists on the value of a comparison of the pupil reaction in the sound as compared with the diseased eye, and on the consensual pupil reactions. Hemianopia occasionally occurs.

Twice I have seen girls who produced a conjunctivitis by putting soap into their eyes. In one it was proved by pouring some atropine solution on the soap and letting it dry in; next day in addition to the conjunctivitis the pupil was dilated. I have seen a girl cured of blindness, by suddenly presenting at

her face a frog, borrowed from the physiological laboratory for the purpose.

During the war many men developed severe blepharospasm. A few went completely blind, their pupils reacting normally; some of them were quite willing to see and rejoiced on the recovery of their sight.

Amongst other manifestations may be mentioned photo-

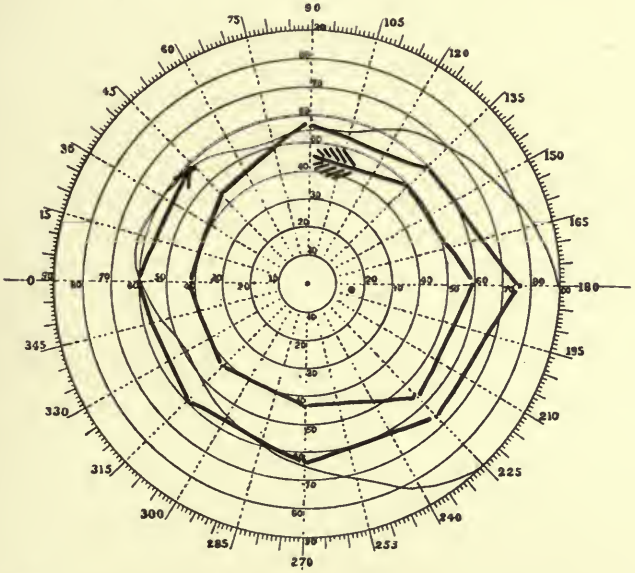


Fig. 34.—Spiral field of vision in a case of hysterical mutism and tremor. Within-outward spiral. (Hurst and Symns.)

phobia, polyopia, monocular diplopia, asthenopia, and other symptoms.

EPILEPSY.

Organic changes in the eyes do not occur with true epilepsy, the presence of papillœdema would be conclusive that epileptiform convulsions were dependent upon a gross cerebral lesion.

Subjective symptoms however, such as auræ, and temporary alterations in the pupils, retinal vessels, and external muscles, occur in connection with true epileptic seizures.

Gowers [1] says a visual warning of epilepsy is twice as common as all the other special sense auræ together.

There may be sudden loss, or dimness of sight, flashes or balls of coloured light may be seen, or objects may seem to grow smaller or larger, to recede or advance, or less definable or highly complex scenes may appear, to usher in the seizure.

Where there is forced rotation of the head during an attack, conjugate deviation of the eyes towards the same side often occurs ; nystagmus and squint are also sometimes seen.

The Pupils.—During the fit the pupils are widely dilated, and except in very mild cases are inactive to light stimulus.

Spratling [2] says he does not recall a single case in which the pupils were not dilated ; it is, however, stated that in the very beginning for a short time they are small.

Ophthalmoscopic Alterations.—It is clear that there are no organic fundus changes in epilepsy, but it seems well established that during the stage of lividity venous engorgement may be evident in the retina.

Gowers [3] says : " I have examined very carefully several thousand epileptics, and have found in most cases every character of the fundus to be such as is presented by persons not epileptic.

" In a case of convulsions from meningeal hæmorrhage, and in another case of one-sided fits, I have been able to keep a retinal artery and vein under direct view through the whole of a severe fit, from before its commencement till after its close. In neither case did the retinal artery present the slightest change in size. During the stage of lividity the vein became large and dark."

Once only have I found one or two small hæmorrhages in the retina after a fit, and presumably caused by it ; their occurrence is certainly uncommon.

At different times by different observers, errors of refraction have been held responsible for most extraordinarily diverse morbid manifestations, from the delayed healing of war wounds

[1] " Diseases of Nervous System," 1893, ii., 739.
[2] " Epilepsy and its Treatment," 1904, 268.
[3] " Medical Ophthalmoscopy," 1904, 191.

to gastritis; but when it is remembered that there are few individuals in whom it is not possible to find at least some trivial refractive error if sufficient assiduity be displayed, it will be granted, that before such an error can be accused of acting as an excitatory factor in the production of epileptic seizures in a predisposed individual, the point requires especially critical examination.

The best answer seems to be supplied by a Commission of the New York Neurological Society [1] which was instituted to consider the contention of Dr. George Stevens, who considered that "difficulties with accommodation and adjusting the eyes in the act of vision, are amongst the most prolific sources of nervous disturbances, and more frequently than other conditions constitute a neuropathic tendency."

The Commission was composed of seven medical men in addition to Dr. Stevens, and they investigated the results of Stephens' treatment by glasses or operation, all other therapeutic measures being excluded. Their finding was, that so far as their investigations warranted a conclusion, the methods used did not afford a sufficient degree of relief to patients suffering from chorea or epilepsy, to justify its adoption or recommendation as a means of cure, or as a sole therapeutic measure.

Starr [2] says it is important in nervous disease to ascertain whether or not any form of peripheral irritation is present, but unless it is serious, and has produced discomfort which has been spontaneously observed by the patient, not much importance is to be attached to it as an ætiological factor. He does not believe that true epilepsy or chorea can be produced by eye strain or cured by its relief.

On the other hand, Wigglesworth and Bickerton [3] came to the conclusion from the examination of 103 epileptics, that "certain cases of epilepsy do occur in which the attack is induced by the undue strain put upon the muscular apparatus of the eye, by reason of an abnormality of refraction."

The point I think does not need labouring, that if in these

[1] *Jour. of Nervous and Mental Dis.*, 1889, 633.
[2] *Medical Record*, 1890, xxxvii., 3.
[3] *Brain*, 1888, xi., 479.

patients a refractive error is present, which, however, is not measured in one-eighth of dioptres, nothing but good will come of its correction; but there seems sufficient evidence to make it certain, that errors of refraction or of the muscular balance of the eyes are at most of trivial importance in the ætiology of epilepsy or chorea.

OPHTHALMOPLEGIA EXTERNA.

Paralysis of the external muscles of the eyes may result from:—

(*a*) Intra-cranial disease, *e.g.*, tumours, meningitis, cerebral syphilis, hæmorrhage, polio-encephalitis, hydrocephalus, pressure of aneurysms or diseased arteries, thrombosis of, or arterio-venous aneurysms in the cavernous sinus, etc.

(*b*) Disease in the orbit as by involvement in growths, or by acute infections of the tissues, abscess or cellulitis.

(*c*) Trauma, as in fractures of the skull, etc. Toxins, as in diphtheria and perhaps syphilis, diabetes, and lead.

(*d*) It may occur as a congenital and hereditary affection.

(*e*) And lastly in a few cases no satisfactory cause is discovered, and these are often attributed to cold or to rheumatism.

In some cases parts only of a nerve are paralysed, the other parts escaping; thus, in the case of the oculo-motorius, the levator palpebræ, superior rectus, or internal muscles may alone be affected, indicating in most cases that the nucleus of the nerve is involved, as in tabes, or polio-encephalitis.

That, however, a partial symmetrical paralysis which would suggest a nuclear lesion may result from a lesion of the nerves themselves, is shown by Thomsen's case,[1] in which impaired upward movement of both eyes resulted from a gumma which involved one third nerve and pressed upon the other.

Diplopia is a usual accompaniment of these palsies, and except in the congenital cases is usually confusing to the patient, so much so, that he will frequently elect to keep one eye completely covered.

In cases of long standing, however, the false image of the

[1] *Centralb. f. Augenheilk.*, 1886, 203.

squinting eye comes to be ignored, diplopia is then no longer troublesome, and the patient is able to walk about without difficulty with both eyes uncovered.

In such diseases as insular sclerosis and myasthenia gravis, it is not uncommon for an intermittent diplopia to be complained of, which no doubt indicates an incipient defect, but is not accompanied by any obvious limitation of movement of the eyes.

And similarly, after the recovery of a paralysis, diplopia, easily elicited and sometimes manifesting itself spontaneously, remains long after any defective movement of the eye is discernible. (See also p. 125.)

Where a muscle is paralysed, an undue effort put forth on the part of the patient in an endeavour to put the weakened muscle into action, is also conveyed to its synergic muscle, with the result that in it an over-action is produced, and a secondary squint occurs ; for the same reason, the position in space of the object producing the true image is falsely estimated.

It often happens that diplopia is limited to that part of the field of vision towards which the eye would be moved by the paralysed muscle, and the patient endeavours, by keeping his head in a certain position, to use that portion only of the visual field in which diplopia does not occur. Thus, for instance, if the right external rectus muscle is paralysed, this eye tends to turn inwards, and if the head and eyes are directed forwards double vision is present ; if, however, the inward divergence is compensated by turning the head laterally to the right, the eyes can now be directed straight forwards without diplopia resulting. This lateral rotation of the head is usually about 20 degrees, is unconsciously assumed, and is very characteristic. A good example of the same compensatory phenomenon is referred to under the head of ocular torticollis.

It is a notorious fact, that paralysis of the ocular nerves is of uncertain value as a localising sign in cerebral disease, and this is especially true of sixth nerve palsies (see p. 42).

Thus, while the nerves, or their nuclei, or the higher co-ordinating centres may be involved in a growth, and their paralysis would have a localising value, in other examples the nerves on one or both sides may be effected by a basal

meningitis, or their conducting power impared by the presence of a tumour, which yet does not directly affect the nerve or its connections; or again œdema of the brain or serous meningitis is apparently a sufficient exciting cause of a sign which must always raise apprehension of the more serious disease.

Uhthoff [1] says :—

(1) A complete bilateral sixth nerve paralysis indicates most probably a basal origin.
(2) Bilateral but incomplete paralysis may be due to tumours within the brain substance.
(3) Unilateral paralysis does not justify the diagnosis of a tumour in the same hemisphere.

It was shown by Mierzejewski and Rosenbach [2] that a lesion of one side of the pons, just above the nucleus of the sixth nerve, causes a loss of movement of *both eyes* towards the side of the lesion.

It is believed that the sixth nucleus is connected with the third nerve nucleus by means of the superior longitudinal bundle, and that the cells of the sixth nucleus produce lateral movement of both eyes towards its side, by stimulating not only the sixth nerve, but also the third nerve of the opposite side, through the intermediation of this bundle.

Having regard to the foregoing, Gowers [3] differentiates three types of sixth nerve paralysis in intra-pontine lesions :—

(1) The external rectus is paralysed, the opposite internal rectus being intact.

    Here the sixth nerve fibres are interrupted peripheralwards of its nucleus, the nucleus being unaffected; impulses to the opposite internal rectus through the superior longitudinal bundle are, therefore, uninterrupted.

(2) The sixth nucleus, and with it often the fibres of the

[1] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1914, xxxiv, 70.
[2] "Neurologisches Centralblatt," 1885, iv., 363.
[3] *Trans. Ophth. Soc. U.K.*, 1887, vii., 269.

seventh nerve, where they curve over the nucleus—is affected.

In this case neither eye can be turned towards the lesion, for no impulse can be transmitted either to the sixth nerve, or to the opposite third nerve through the superior longitudinal bundle.

(3) There is loss of movement of both eyes towards the lesion, but not complete palsy of the external rectus.

The eye cannot be moved beyond the middle line, but it does not deviate inwards.

In this case there is no disease of the sixth nucleus, but the lesion is in the tegmentum of the pons, damaging the centre or path for conjugate movements.

Paralysis of the third nerve may be "distant" in its causation, though less often than paralysis of the sixth, thus:—

Uhthoff reports two cases of single oculo-motor paralysis; in which post-mortem there was no sort of direct involvement of the nerve or nucleus. He says, "a unilateral isolated complete third nerve paralysis may therefore be sometimes caused by pressure from a distance, whereas bilateral paralysis, an association with paralysis of the crossed half of the body, or simultaneous paralysis of other cerebral nerves, afford safe indications of a basal origin."

Further, he states that paralysis of single branches of the nerve, especially that going to the levator palpebræ, more often indicates a lesion of the nerve through pressure from a distance, than involvement of the nerve trunk or cerebral cortex.

Owing to the close proximity of the two third nuclei to each other, and also of the nerves where they leave the brain in the interpeduncular space, a single lesion, either in the latter situation, or in the region of the corpora quadrigemina may involve both nerves. Goldzieher [1] reports a case in which there was paralysis of all the muscles supplied by both third nerves, associated with weakness of the lower limbs and a staggering gait. A tuberculous tumour the size of a hazel nut was found post-mortem just under the corpora quadrigemina.

[1] *Centralblatt für Augenheilk.*, 1893, 44.

He concludes, that ophthalmoplegia with inco-ordination of the lower limbs points to a lesion of the corpora quadrigemina.

Bruce [1] reports a case in which upward movement of the eyes was completely absent, downward movements were imperfect, but lateral movements were complete; there was a tendency for the patient to fall backwards when she shut her eyes; paralysis of the elevators of the lids developed one day only before death. At the post-mortem a glioma was found, "extending from a point midway between the two corpora quadrigemina, as high as the third ventricle, into the posterior part of which it projected like half a bean." The anterior part of the third nucleus was involved, but its posterior part and the nucleus of the fourth nerve had entirely escaped.

Gowers [2] says: "Paralysis of the upward movement of the eyes has often been observed associated with paralysis of the levators. It may result from disease of the posterior part of the third nerve nucleus. It is possible also that there is a higher centre, disease of which may paralyse upward movements without the lid. I have recorded one such case in which this symptom was well marked. A very small tumour was found in the mid-line behind the posterior quadrigeminal bodies, damaging these slightly, the velum, and the adjacent part of the inferior vermis of the cerebellum."

Ferrier [3] gives the following as symptoms of involvement of the corpora quadrigemina:—

A markedly reeling gait, which most often develops before ocular symptoms.

Ptosis, limitation of vertical eye movements, and limitation of lateral eye movements in this order.

He states that there is no evidence that the anterior corpora quadrigemina are concerned with visual sensation, and that the ocular symptoms are due to the involvement of the underlying oculo-motor nuclei.

Aldren Turner likewise remarks that removal of the quadrigeminal bodies in monkeys does not cause ocular paralysis,

[1] *Trans. Endinburgh Medico-Chir. Soc.*, 1899, xix., 206.
[2] "Diseases of the Nervous System," 1893, ii., 185.
[3] "Allbutt and Rolleston," Syst. of Med., 1910, viii., 120.

if care is exercised to avoid damaging the grey matter around the Sylvian aqueduct.

It would seem, then, that the association of a reeling gait with oculo-motor palsies, in which the muscles producing vertical movements are primarily involved, is suggestive of a lesion in the region of the corpora quadrigemina.

Gordon Holmes [1] believes that a lesion of the anterior end of the mid-brain will involve upward movements, downward movements, and convergence, in this order as it progresses from before back, and states that paralysis of the pupil is often associated with loss of upward movement, and loss of convergence with paralysis of downward movement.

As in the case of conjugate lateral movements, it is probable that there is a superanuclear centre to control conjugate vertical movements, but its site is not accurately known.

Congenital and hereditary paralysis of the ocular muscles are common, and many pedigrees are fully reported. In some the external recti alone are involved, in others there is ptosis, and in others again there is complete ophthalmoplegia externa, associated in a few cases with facial paralysis.[2]

Chronic Progressive Ophthalmoplegia Externa.—Under this title may be classed a group of cases which was first identified by Wilbrand and Saenger.[3]

The characteristics are :—

(1) A slowly progressive lesion which is bilateral, and which, in most cases, ends ultimately in complete or nearly complete ophthalmoplegia externa.
(2) The onset is usually in early life and is gradual.
(3) It is unassociated with any other morbid condition of the nervous system and does not shorten life.

Ptosis is usually the first sign.

Hine and McMullen,[4] in reporting three cases, state that in six only out of thirty-eight reported cases was the age at onset

[1] *Trans. Roy. Soc. Med.*, Neurol. and Ophth. Sec., March, 1921.
[2] Bradbourne, *Trans. Ophth. Soc. U.K.*, 1912, xxxii., 142 ; Harlan, *Trans. Amer. Ophth. Soc.*, 1880, iii., 216, and iv., 48 ; Berry, *Ophth. Review*, 1886, v., 34 ; Nettleship, *Trans. Ophth. Soc. U.K.*, 1909, xxix., clxxxviii., Bowman Lecture.
[3] "Neurologie des Auges," Wiesbaden, 1900.
[4] *Trans. Royal Soc. Med.*, Ophth. and Neurol. Sections, March, 1921.

over thirty; they say the condition is attributed to an abiotrophy of the cells of the third nerve nucleus, the time of onset depending on the degree of vitality with which the cells were originally endowed.

OPHTHALMOPLEGIA INTERNA.

Every now and then a patient is seen with unilateral ophthalmoplegia interna, which is apparently permanent, and for which there is no discoverable cause either at the time or ultimately. I have seen a patient in whom it was known to have been present for twenty-four years without alteration in any way.

Uhthoff collected thirty cases of ophthalmoplegia interna, in twelve of which no cause was discovered. They were all young and were said to be of a neuropathic disposition; in most of them the symptoms were of short duration, but in one they had been present without change for twenty years. He suggests that some such cases may be due to ptomaine poisoning.

Similar cases are reported by v. Hippel,[1] who states his patients had neuropathic tendencies; Levinsohn[2]; and Bramwell and Sinclair.

In addition, it is not very rare to come across pupils which are quite inactive to light stimulus, whether direct or consensual, but which contract slowly with accommodation, taking some seconds to attain complete contraction, and are as slow in again relaxing.

They are unilateral; the function of accommodation is quite unimpaired.

They are unrelated to syphilis or any general nervous disorder. I have notes of five cases, in one of which the condition was known to have been present for more than forty years, and in another for more than twenty.

The features are the unilaterality, the intact accommodation, the tardiness of the reaction with accommodation, the permanency of the condition, the absence of any general nervous disorder, and the absence of syphilis.

[1] *Klin. Monats. f. Aug.*, 1906, 97.
[2] *Archiv. of Ophth.*, 1901, 166.

HYDROCEPHALUS.

Owing to the bulging downwards of its roof, the orbital cavity is a good deal distorted in this condition; the eyes consequently become rotated downwards and are largely covered by the lower lids; the upper lids tend to be drawn upwards by the tightness of the scalp.

Still states that in some cases the children acquire the habit of drawing down their own lower lids in order to see.

Any prominence of the eyes is masked by the bulging frontal region, and marked proptosis is rare.

Defects of vision are common, but good vision may be retained though the head is greatly enlarged.

All observers are agreed that these defects depend upon a primary optic atrophy and that papillœdema does not occur.

Thus, Cushing [1] says: "A pressure sufficient to produce an advanced degree of choked disc cannot well occur, as the cranium is so easily distensible."

Still says: "Optic neuritis is almost never seen with congenital hydrocephalus; its presence always points to cerebral tumour as the cause of the hydrocephalus"; and Gowers [2]: "In several cases the onset of the atrophy has been watched, and the occurrence of any neuritic process excluded."

Batten [3] says: "Nystagmus is frequent and may be lateral vertical or rotatory; squint from ocular paralyses is often present."

ENCEPHALITIS LETHARGICA.

This epidemic disease to which various titles have been applied, has come into much prominence in Europe and America during the last three years.

Paralysis of the cranial nerves and especially of the ocular nerves is one of its prominent features; so much is this the case that "Acute Infectious Ophthalmoplegia" and "Toxic Ophthalmoplegia" are amongst the names which have been applied to it.

[1] Osler and McCrae's "Sys. of Med.," vol. v.
[2] "Med. Ophthal.," 160.
[3] Garrod and Thursfield "Diseases of Children," 1913, 817.

The other prominent clinical features are those of an acute general infection, associated with apathy passing into lethargy, and great muscular debility.

The ocular symptoms consist of paresis or paralysis of some of the ocular nerves, nystagmus, photophobia, and, in a few cases, changes in the optic discs. It is a feature of the paralyses that they are often evanescent or intermittent and incomplete. Thus it is common for certain muscles which are supplied by the third nerve to be involved, the others escaping; the affected muscles are often only partly paralysed; ptosis is the most common partial manifestation.

Diplopia may be a very early prodromal sign which quickly disappears as the disease becomes established; this was the case in 20 per cent. of the 168 cases investigated by the Local Government Board, London.[1] It may afterwards recur and become protracted.

Of the above cases 75 per cent. had paresis or paralysis involving the third nerve, and of ninety-seven cases which I have collected [2] 75 per cent. had some ocular palsy.

Ptosis is the most common defect and in 25 per cent. of the Local Government Board cases it was unilateral.

In 27 per cent. of my collected cases the sixth nerve was involved, but some of the cases labelled diplopia should be added to this figure.

Various changes in the pupils have been noted, but there does not appear to be any characteristic feature of them, and involvement of the internal branches of the third nerve is very unusual; it is mentioned in three of my ninety-seven cases.

Papillœdema is rare; it is mentioned in four of the above cases. The Local Government Board Report says: "Optic neuritis has been seen exceptionally. Its occurrence, however, seems to be limited to cases in which hæmorrhagic infarction

[1] Report of the Local Government Board on Encephalitis Lethargica, No. 121, London, 1918.

[2] Ely, *Jour. Amer. Med. Ass.*, lxxii., 985; Pothner, *Jour. Amer. Med. Ass.*, lxxii., 715; Tucker, *Jour. Amer. Med. Ass.*, lxxii., 1448; Wegeforth and Ayer, *Jour. Amer. Med. Ass.*, lxxiii., 5; Kinnier-Wilson, *Lancet*, 1918, ii., 7; Gordon, *N.Y. Med. Jour.*, cix., 837; Sachs, *N.Y. Med. Jour.*, cix., 894; Hall, *B.M.J.*, 1918, ii., 461; Melland, *B.M.J.*, 1918, i., 559; Dunn and Heagey, *Amer. Jour. Med. Sci.*, clx., 568; Netter, *Bull. et Mem. Soc. Med. des Hopitaux de Paris*, xlii., 307.

into the brain substance has taken place. This gives rise to general cerebral hyper-tension with consequent optic neuritis."

Of seventeen cases which I have examined ophthalmoscopically, in no case did the fundi show any change which could be referred to the disease.

Nystagmus was mentioned in 9 per cent. of the ninety-seven cases.

Ocular palsies are frequently the first symptom of the disease,

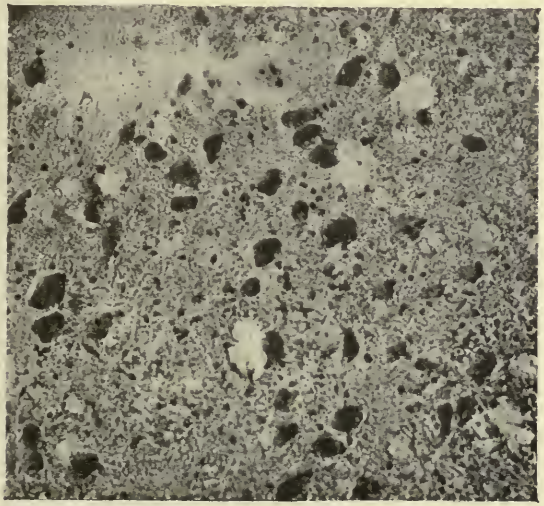


Fig. 36.—A section through the abducens nucleus from a case of "epidemic encephalitis." The large motor cells show changes varying from intense cloudy swelling to a moderate degree of chromatolysis, in a few instances the cell bodies showed vacuolisation. There were numerous small hæmorrhages apparently in relation to the veins, all of which were intensely injected. (Tilney and Howe, "Epidemic Encephalitis," New York, 1920, 15.)

and so also they may be the last to disappear after the patient is convalescent; occasionally they are permanent. I have seen a man in whom residual paralysis of both third nerves was marked twenty-one months after the onset of the disease. Of the Local Government Board cases, twenty-six were examined at various times after recovery; fourteen of them still had ocular palsies at an average period of nine weeks after the onset of the disease.

Pathological evidence shows that the most advanced changes are to be found in the mesencephalon in the region of the third nerve nucleus.

Tilney and Howe [1] describe the degenerative changes in the cells of the nuclei of the nerves, cellular infiltration, vascular engorgement and small hæmorrhagic areas. Of the sixth nerve nucleus (Fig. 36), they say :—

"The large motor cells showed evidence of acute change, varying from intense cloudy swelling to a moderate degree of chromatolysis. In a few instances the cell bodies showed vacuolisation."

The vascular picture was similar to that observed in the medulla, and was characterised by numerous small hæmorrhages apparently in relation to the veins, all of which were intensely injected.

POLIO-ENCEPHALITIS.

The occurrence of a paralytic internal squint in young children with a history of some recent infectious disease is often due to acute polio-encephalitis.

Stephenson reports twenty-eight cases in three-quarters of which the external rectus was involved.

Batten points out that they are often associated with a rhythmic tremor of the limbs, and some other cranial nerve palsies,[2] and Holden [3] remarks that the usual absence of involvement of the intrinsic eye muscles is a distinctive feature of some differential value.

A case in which almost complete recovery of movement occurred in a month is reported by Greeves.[4]

THE INTRA-OCULAR LESIONS IN TABES AND GENERAL PARALYSIS.

The Argyll Robertson pupil is almost invariably of syphilitic origin, either acquired or congenital, and rarely occurs apart from tabes or general paralysis; it is, however, true that the pupils

[1] "Epidemic Encephalitis," Paul Hoeber, New York, 1920.
[2] *Lancet*, 1916, 809.
[3] *Trans. Amer. Ophth. Soc.*, 1906-8, xi., 220.
[4] *Trans. Ophth. Soc. U.K.*, 1912, xxxii., 104.

of a patient who is blind will usually contract with convergence, though they are inactive to light stimulus.

Gowers comments on the absence of pupillary changes in other spinal diseases in which Rombergism, ataxy, and changes in the knee jerks may all occur, and especially on their absence in combined sclerosis of the lateral and posterior columns.

The actual site of the responsible lesion cannot be considered as definitely settled. Bumke's [1] great weight and authority in the matter, however, locate it in the terminal ramifications of the centripetal fibres from the retina in the neighbourhood of the iris sphincter centre. By some the lesion is placed in the cells of the partial nucleus of the third nerve,[2] and by others in the ciliary ganglion.

Wilfred Harris [3] suggests that, in conformity with the degenerations in the posterior columns of the cord, the lesion is more likely to be in nerve fibres than in cells. He points out that in birds and some lower animals there is a complete decussation of the optic nerves, and that in them the consensual pupil reaction does not occur ; there must, therefore, be a complete posterior decussation between the optic lobes and the third nerve nucleus. He argues similarly that in man, with binocular vision and a semi-decussation of the optic nerves, a corresponding posterior semi-decussation holds good between the anterior corpora quadrigemina and the oculo-motor nucleus, which subserves the light reflex. This semi-decussation he locates in Mynert's bundle which goes from one anterior corpus quadrigeminum to both third nerve nuclei, and he suggests that the lesion in the Argyll Robertson pupil is a sclerosis of one or other of these bundles, according as the loss of light reflex is uni- or bi-lateral.

Incidence.—Of seventy-seven cases of tabes examined by Rochon Duvigneaud and Heitz [4] in four only could the pupil reaction be considered normal, and of seventy-two cases examined by Gowers [5] the internal muscles of the eye were

[1] " Die Pupillenstorungen bei geister und nerven krankheiten," Jena, 1911.
[2] Sturge, *Trans. Ophth. Soc. U.K.*, 1881, i., 177.
[3] *B.M. Jour.*, 1900, ii., 924.
[4] *Archiv. gén. de Méd.*, 1903, cxcii., 1675.
[5] *Trans. Ophth. Soc. U.K.*, 1883, iii., 198.

normal in six only. In 1,036 cases of general paralysis Junius and Arndt [1] found a disturbance of the light reflex in 93·8 per cent., and in 65·8 per cent. it was totally lost. Bevan Lewis [2] in sixty patients found impaired reaction to light in 78 per cent.

It is not rare to find one pupil only affected; thus twenty-three of Junius and Arndt's cases were unilateral, and Oliver [3] notes a similar proportion.

In 30 per cent. of Rochon Duvigneaud and Heitz's cases there was bilateral diminution, or loss of reflex contraction with convergence, and in 13 per cent. it was unilateral.

Cycloplegia.—This was present in six out of Gowers' seventy-two patients, and in two accommodation was lost on one side only, although the light reflex was absent on both sides. In 15 per cent. of Gowers' cases the pupils were inactive with convergence as well as to light stimulus, and in most of these cycloplegia was also present; in two of them it was unilateral. Cycloplegia is seldom present with a small pupil; on the other hand, if the pupil is large and the vision is good paralysis of accommodation will often be found to be present.

A variation in the size of the two pupils is so common as to be usual, and they are often uneven in shape; it is also common to find that they dilate very little with mydriatics.

Under the head of a "springing pupil," Oppenheim speaks of the association of alternate dilatation of the pupils with inactivity to light stimulus and says it is a symptom or prodrome of tabes or general paralysis.

Optic Atrophy.—Loss of sight due to optic atrophy is not infrequently the first symptom for which advice is sought, it may, however, occur late in the disease and then its progress is usually slow. Gowers [4] has seen optic atrophy precede locomotor symptoms in one case by twenty years, and in another by fifteen, but he states it has never been proved that optic atrophy precedes loss of knee jerks.

Both eyes are always involved, but one is usually affected

[1] *Arch. f. Psych. und Nervenkr.*, 1908, xliv., 2, 493.
[2] *Trans. Ophth. Soc. U.K.*, 1883, iii., 204.
[3] *Trans. Amer. Ophth. Soc.*, 1891, vi., 544.
[4] *Trans. Ophth. Soc. U.K.*, 1883, iii., 193.

before the other, and the eye which first is bad maintains the lead throughout; it is, however, unusual to find the sight of one eye badly deteriorated without the other being involved in some degree.

Frequency.—Kurt, Mendel, and Tobias [1] found thirty-six cases of marked optic atrophy amongst 430 tabetics, and Gowers [2] states: "Of the last 400 cases of tabes I have seen, optic atrophy existed in twenty-six (6·5 per cent.)."

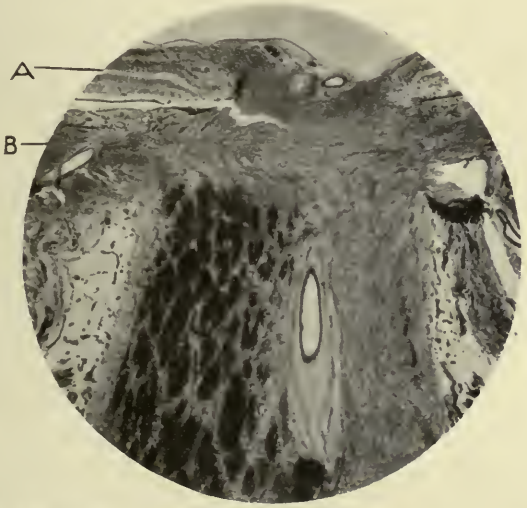


FIG. 37.—A longitudinal section through the optic nerve in a case of tabetic atrophy. *A*. Retina. *B*. Sclerotic.

Amongst seventy-six cases of progressive optic atrophy, excluding post-papillitic cases, examined by Nettleship, thirty-eight were undoubtedly tabetic.

The Relation of Optic Atrophy to Ataxia.—It has long been recognised that in tabetics who develop optic atrophy, the onset of ataxia is usually much delayed.

Thus Gowers says: "When atrophy commences in the early stages, the progressive tendency is often strong, and that of the spinal disease slight, and conversely, when the atrophy com-

[1] "Die Tabes der Frauen," Berlin, 1912.
[2] "Med. Ophthal.," 1904, 181.

mences later in the disease, after the alteration in the gait has become well marked, the tendency of the atrophy to progress is much less marked. Buzzard found four cases only of ataxia amongst fifteen blind patients. Förster[1] found thirteen cases of optic atrophy amongst twenty-seven patients in the pre-ataxic stage, whereas he found six only amongst fifty-eight patients in whom ataxia was present; further, he found that the average preataxic period was four-and-a-half years where there was no optic atrophy, but that when optic atrophy was present this period averaged nine-and-a-half years.

Maloney[2] does not believe that this partial dissociation of optic atrophy and ataxia is indicative that the morbid process affects more especially the corresponding parts of the central nervous system in the respective groups, but that the explanation is to be found in the fact that blindness increases co-ordination and so mitigates ataxia. He quotes the investigations of Slinger and Horsley.[3] These observers showed that those who are blind, whether from tabes or any other cause, possess a "greater muscular and arthrodial sense accuracy"; they state: " . . . if the information gained by sight is permanently blotted out, the muscular sense, under necessity can, by education, be brought to a point at least one-quarter better than that learnt by normal seeing individuals."

Maloney concludes that neither the occurrence of optic atrophy nor of blindness retards or influences the evolution of the structural changes which accompany the tabetic process in the spinal cord or elsewhere, and that improvement in ataxia will result from a lack of vision after an adequate interval has elapsed—

(*a*) When inco-ordinating lesions remain stationary and the mental capacity for training is not destroyed by cerebral disease.

(*b*) Even if the structural tabetic lesions leading to inco-ordination extend, provided that the effect of this

[1] Quoted by Maloney.
[2] *Jour. of Nervous and Mental Diseases*, 1913, xl., 572
[3] *Brain*, 1906, xxix., 26.

extension be less than the compensatory influence of the blindness.

Thus, of two tabetics at any stage of the disease, one blind, the other seeing, *ceteris paribus*, the blind has the greater tendency to persist co-ordinate, the lesser tendency to become ataxic.

The degree of this compensatory improvement of co-ordination will, *ceteris paribus*, tend to rise with the duration of the blindness according to the training capacity of the person.

Fields of Vision.—It has been demonstrated by Fuchs[1] that the occurrence of a central scotoma is not very rare in tabes. At first the scotoma is for red and green, and involves the yellow spot and is associated with an enlargement of the blind spot.

Later these two blind areas enlarge and coalesce and the loss of sight over them is absolute. The condition is separated from toxic amblyopia by its malignant course, by the contraction of the peripheral field, and by the fact that colour perception is interfered with throughout the field of vision.

With regard to its relation to the general disease, Fuchs says: "I do not think of denying that cases of syphilitic retrobulbar neuritis do exist, but I affirm, that in the great majority, the central scotoma does not form an accidental complication, but an integral part of the tabetic process."

Nettleship pointed out that the last part of the visual field to disappear was often in the lower temporal area—an area, it may be noted, which is the last part to disappear when the temporal field is lost in pituitary lesions, and which is sometimes spared in embolism of the central retinal artery.

Uhthoff estimated the frequency of a central scotoma as about 2 per cent., Galezowski and Lobel[2] at from 2 to 4 per cent.

On six occasions Fuchs has seen bitemporal hemianopia,

[1] *Archiv. of Ophth.*, 1911, xl., 469; *Trans. Amer. Ophth. Soc.*, 1909-11, xii., 718.
[2] *Recueil d'Ophth.*, April, 1906.

which he believes to be an essential part of the disease in such cases.

Whilst loss of impairment of colour vision is very common in tabes, Dodd [1] reports a case in which the patient after having for some years failed to appreciate red, suddenly saw everything as through a brilliant green curtain. He collects [2] thirteen cases of green vision, all but three of which occurred with disease of the optic nerve or retina.

FRIEDREICH'S ATAXIA.

According to Friedreich's original account, the only eye lesion of this disease is nystagmus, and all authors agree in considering other ocular lesions as of quite unusual occurrence.

Nystagmus is exceedingly common, especially in advanced cases, and Posey and Spiller [3] say that only very rarely is it absent. Gordon Holmes,[4] however, whilst agreeing that it is common, says it cannot be looked upon as one of the essential symptoms of the disease.

It usually occurs only on volitional movement, and especially in the horizontal plane; it is not as a rule present when the eyes are at rest.

Other symptoms which have been reported are paralysis of one or other of the external ocular muscles, diminished reaction of the pupils to light, reduction in the visual fields and optic atrophy.

ACUTE MYELITIS WITH RETRO-BULBAR NEURITIS.

Under some title similar to the above a number of cases of a disease which is probably a clinical entity, have been recorded.

The association of the two conditions was remarked by Sir Clifford Allbutt,[5] and in 1914 Goulden [6] was able to collect

[1] *Trans. Ophth. Soc. U.K.*, 1899, xix., 281.
[2] *Trans. Ophth. Soc. U.K.*, 1900, xx., 264.
[3] "The Eye and Nervous System," 475.
[4] Allbutt and Rolleston's Syst. of Med., 1910, vii., 775.
[5] *Lancet*, 1870, i., 77.
[6] *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., 229.

fifty-two reported cases. The disease is acutely febrile, and is characterised by rapid, severe loss of sight, and symptoms of acute myelitis, and in a majority of cases it ends fatally. In four-fifths of the cases loss of sight is the first symptom. It may precede the myelitis by several days (Goulden); it is rapid and may be complete in twenty-four hours.[1] In other cases the eye symptoms follow the spinal symptoms.

FIG. 38.—"Acute myelitis with retro-bulbar neuritis." A transverse section through the spinal cord in the cervical region, showing a large patch of myelitis in the dorsal columns of the cord. (Gordon Holmes.)

In nineteen out of twenty-one cases both eyes were affected (Katz).

The ophthalmoscopic changes are slight, and do not attain a degree to which the term papillœdema is applicable. Other cranial nerves are not involved. A majority of cases are fatal within a short time,[2] but if the patient survives, there is a tendency towards recovery of both the cord and eye condition. The lesions are probably dependent upon a common bacterial toxin.

[1] Katz, *Archiv. für Ophth.*, 1896, xlii., 1, 202.
[2] Chisholm, *Archives of Ophth.*, 1882, 239.

Complete pathological examinations of the cord and optic nerves have been made by Holden,[1] Bielschowsky,[2] Sharkey and Lawford,[3] Gordon Holmes [4] (Fig. 38). There is but little divergence in the pathological findings of different investigators. All agree that the lesions are strictly focal. There are localised areas of softening and necrosis, with considerable perivascular lymphocytic infiltration (Gordon Holmes), and neuroglial overgrowth (Holder). Bielschowsky shows that the infiltration is in connection with individual vessels. The myelin sheaths are completely destroyed, but a considerable proportion of the axis cylinders persists, though many are of irregular contour (Gordon Holmes). Sharkey found acute inflammation of the optic disc and nerve, the chiasm and tract being less involved.

DISSEMINATE SCLEROSIS.

This is a disease of young adults ; it is exceedingly seldom, if ever, seen in children, and it is rare for it to come to notice for the first time after the age of forty. Thus, 85 per cent. of Byrom Bramwell's cases occurred between the ages of fifteen and thirty-five ; and twelve only out of 100 cases examined by Uhthoff were under twenty years of age.

A number of important ocular lesions occur, and as they are frequently the first symptom of the disease, the ophthalmic surgeon often sees these patients in the first instance.

The chief of the defects may be considered under the heads of changes in the visual tracts, defects of the fields of vision, and defects of muscular action.

Ophthalmoscopic Change.—By far the most frequent and important ophthalmoscopic change is the occurrence of varying grades of optic atrophy ; this may be slight, or rarely marked, but complete atrophy of both discs at all comparable with that which may be seen in tabes, leading to complete blindness, is almost if not quite unknown.

[1] *Trans. Amer. Ophth. Soc.*, 1909-11, xii., 728.
[2] " Myelitis und Sehnervenentzündung," Karger, Berlin, 1901.
[3] *Trans. Ophth. Soc. U.K.*, 1884, iv., 232.
[4] *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., 246.

In this, as in optic atrophy from other causes, there is often a marked disproportion between the colour of the disc and the visual defect, the sight may be either much better or much worse than would have been predicted from the colour of the disc, and as is to be expected from the pathology of disseminate sclerosis, the eyes may be very unequally involved.

In a majority of cases the atrophy appears to be a simple degenerative process so far as ophthalmoscopic evidence is concerned, for in few is there evidence of active changes in the optic papilla to which the term papillœdema or optic neuritis could be applied. In a small proportion, however, such active changes may be seen, and when they occur they are probably indicative of an area of active degeneration close behind the optic nerve entrance. They do not imitate at all closely the great swelling and œdema of the nerve head that occurs with a cerebral tumour, to which the term papillœdema is so appropriately attached; nor do they indicate the increase of intracranial pressure which papillœdema implies. The disc is slightly swollen and its edges are hazy, the presence of hæmorrhages or exudate is unusual; the moderate changes are short-lived and may leave a normal-looking disc on their disappearance, but in most cases a varying degree of atrophy subsequently develops. The more common cases of atrophy, without evidence at any time of active change in the disc so far as is known, are probably due to a patch of sclerosis in some portion of the nerve remote from the globe.

Three cases with "mild optic neuritis" are reported by Sharkey and Nettleship.[1] Nettleship says:[2] "If the optic nerves suffer in disseminate sclerosis they seldom suffer profoundly, and often recover partially, and that the process is more acute, and to the opthalmoscope more inflammatory than in tabetic atrophy."

Uhthoff believes that ophthalmoscopic evidence of active change is more common than is generally believed, the neuritis running a rapid course and leaving no evidence of its previous existence.

[1] *Trans. Ophth. Soc. U.K.*, 1883, iii., 225 and 227.
[2] *Ibid.*, 254.

In recording three cases in which active disc changes were present, Paton [1] summarises the changes thus :—

(1) The loss of sight precedes the disc changes.
(2) The ophthalmoscopic changes are of very short duration.
(3) The disc may show no trace of pathological change after the swelling has subsided.
(4) The recovery of the vision is usually synchronous with the subsidence of the swelling.

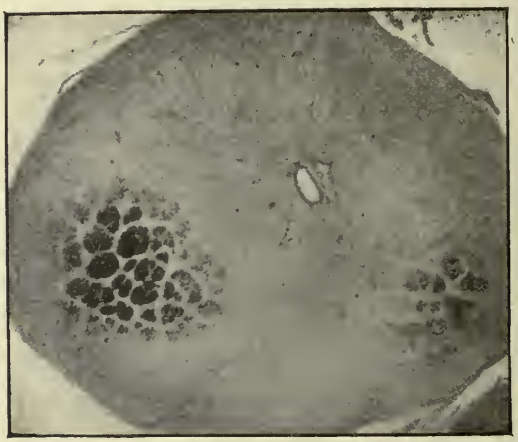


FIG. 39.—A transverse section through the optic nerve a short distance behind the globe extensively involved in a patch of sclerosis, the part around the central vessels being as usual especially affected. (Velter.)

He suggests that when disc changes are found to be of very short duration, disseminate sclerosis should be had in mind.

Uhthoff found ophthalmoscopic evidence of some degree of optic atrophy in forty-five out of 100 cases examined by him. Buzzard found pallor of the discs in 43 per cent. of cases.

The Loss of Sight.—It is by no means rare for loss of sight to be the earliest sign of the disease ; such cases almost invariably come first into the hands of the ophthalmic surgeon, and are labelled retro-bulbar neuritis, the cause of which is by no means

[1] *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., 257.

always certain, and it is only the subsequent history and progress which makes its nature clear.

The defect may develop gradually or may be rapid or sudden in its onset ; it is variable in its degree, is frequently unilateral, and often temporarily disappears, only to recur at a later date ; alternate loss of sight with recovery may recur several times before marked ophthalmoscopic changes are seen, and the amblyopia becomes permanent.

Of sixteen cases of retro-bulbar neuritis, Marx [1] found six subsequently developed insular sclerosis, and Gunn [2] found that of 233 cases of primary retro-bulbar neuritis, fifty-one were due to this disease.

Retro-bulbar neuritis may precede all other symptoms of insular sclerosis by as long as ten years.[3]

Muscular Abnormalities.—Paralysis or paresis of one or other of the ocular muscles is frequent, and as in tabes, may be the first sign of the disease, and may disappear.

Diplopia ensues, but is often fugitive and varies much in its degree, it has not the stability, nor is it so confusing, as the diplopia which arises from many other acquired ocular palsies. The defective movement causing the double vision may be so slight as not to be easily identified. The nerve most often affected is the abducent, a partial ocular motor paralysis being next most common.

Kampherstein [4] found ten cases of muscular defect amongst thirty-seven cases of insular sclerosis.

Nystagmus.—This is one of the classical signs, and is of very frequent occurrence in some stage of the disease. It was present in fifty-eight out of 100 cases.[5] It may be present with the eyes at rest, but this is not usual, more often it is elicited on asking the patient to look towards the periphery in one or other direction, especially laterally ; in addition, Edwin Bramwell[6] describes as nystagmoid, movements which

[1] *Archiv. f. Augen.*, 1908, lix., 28.
[2] *Lancet*, 1904, ii., 412.
[3] Fleischer, *Die Ophth. Klinik*, x., 19.
[4] *Archiv. f. Augen.*, 1903, xlix., 41.
[5] Uhthoff, " Dissem. Scler.," Hirchwald, Berlin, 1889.
[6] Osler's " System of Medicine," 1915, v., 151.

occur during fixation, but which rapidly cease, and are at the same time frequently irregular in rhythm and amplitude.

If nystagmus is looked upon as a form of the intention tremor which is so common in disseminate sclerosis, then the explanations of the mode of its production are the same as those put forward for the intention tremors.

Thus Charcot says, the axis cylinders being denuded of their myelin sheaths, offer a varying resistance to the passage of impulses at different parts of their course, the impulses in different axis cylinders consequently arrive at their muscular endings at irregular times, and produce irregular contraction in the muscle.

Risien Russell [1] says: "Of all the possible explanations which have been offered of the way in which the intention tremor results, none appear to me to be so satisfactory, as that which supposes it to be due to a failure of synergic action of muscles in purposive movements, consequent on an unequal degree of innervation both of the muscles directly concerned and of their antagonists."

Fields of Vision.—Changes of the visual fields are frequent, in some cases central vision is affected, the scotoma being either for colours only or sometimes being complete. In other cases central vision is unaffected, but the peripheral limits of the field are constricted, usually in an irregular manner. In other cases again, the two foregoing conditions are combined in varying degrees.

Of fifteen cases, Kampherstein found eight belonged to the first group, four to the second, and three to the third group. Uhthoff's [2] figures are in close agreement. He says that in one-half of all cases with defects of the visual fields there is a central scotoma, usually bilateral, often relative, with no alteration in the peripheral field. Irregular peripheral contraction with intact central vision is frequent; peripheral contraction combined with central scotoma is rare; in a few cases regular concentric constriction occurs.

Pupillary Abnormalities.—The pupillary changes which may

[1] Allbutt's "System of Med.," 1910, vii., 830.
[2] "Ophthalmoscope," 1905, 431.

occur in disseminate sclerosis are dependent upon, and vary with, the existence of local changes in the tracts concerned in the pupillary reflex, and are in no way distinctive of this disease.

Pathological Changes.—The pathological changes which develop may occur in any part of the central nervous system and in the peripheral nerves.[1] The islands of sclerosis arise in an entirely indiscriminate manner throughout the nervous

Fig. 40.—Section through the optic chiasma showing degenerative areas in a case of disseminate sclerosis.

system, and thus is explained the varied manifestations and course of the disease.

The sites of predilection are, according to Dawson,[2] related to (1) the terminal ramifications of end arteries, (2) to areas where much glia is normally present, *e.g.*, the optic chiasma (Fig. 40). Dawson found that the optic chiasma and one or both optic nerves were affected in seven out of eight cases in which they were examined, and in six of them there was extensive involvement of the optic radiations on both sides. The earliest changes

[1] Tredgold, *Rev. of Neurol. and Psych.*, 1904, ii., 497.
[2] *Trans. Roy. Soc. of Edinburgh*, 1916, l., 517.

which occur are in the myelin sheaths ; these first undergo cloudy swelling, followed by fatty degeneration, and later, complete absorption occurs, leaving the axis cylinder completely bare. For a long time the denuded axis cylinders may maintain their functions, or they may temporarily be thrown out of gear to recover for a time later on, but ultimately they become irregularly swollen, broken up and absorbed. As a result of these changes, proliferation of the neuroglia takes place producing the patches of sclerosis ; the sclerosis on this view is a secondary development (Tredgold).

Uhthoff on the other hand looks upon the changes in the connective tissues as primary, and the destruction of the nerve tissue as a secondary result of this. As a result of the complete interruption in their course, descending atrophy of the nerve fibres occurs, but this, as pointed out by Uhthoff, may be much less complete than would be expected ; ultimately in the later stages atrophy of the nerve cells occurs as a consequence of the destruction of their axis cylinders.

SYRINGOMYELIA.

The ocular changes which occur in this disease may be considered under three heads :—

(1) Involvement of the external ocular muscles.
(2) Pupillary changes.
(3) Fundus changes.

(1) Schlesinger [1] in examining 300 cases of this disease, found paresis or paralysis of some or other ocular muscle in thirty-three cases. The sixth nerve, usually on one side only, is the one most often affected, but the third nerve may be partly involved. When these nerves are affected, it probably implies that the gliomatous process has extended as high as their nuclei, and consequently symptoms of involvement of other bulbar nuclei are generally present.[2]

Spiller has reported a case in which the process extended as high as one cerebral peduncle.

[1] " Die Syringomyelie," Leipzig u. Wien, 1902.
[2] Starr, Allbutt's " System of Med.," 1910, vii., 862.

The paralysis may be transient, and when ptosis occurs, some care is needed to decide whether this is due to involvement of the oculo-motor nerve or to sympathetic involvement.

Nystagmus is a fairly common symptom, and comes on early in the disease. Schlesinger found fourteen cases of true nystagmus, and thirty-seven of nystagmoid movements, among 330 cases of syringomyelia: the cause of the nystagmus is not known.

(2) **Pupillary Changes.**—These changes are caused by involvement of the sympathetic fibres as they traverse the spinal cord.

Farquhar Buzzard [1] says: "Owing to the frequent involvement of the first dorsal and eighth cervical segment by the gliomatous process, oculo-pupillary symptoms occur in about 85 per cent. of cases; as a rule the paralysis of the sympathetic fibres is unilateral, or is more advanced on one side."

If the fibres of the sympathetic are involved the ordinary signs will be present (see p. 96).

(3) **Ophthalmoscopic Changes.**—These are quite unusual, and it would seem clear that in some of the reported cases the change is due to other conditions. In a few cases, however, papillœdema and optic atrophy have been seen. It is suggested that the former is due to internal hydrocephalus; cases are reported by Saxer,[2] Bullard and Thomas,[3] and Weisburg.

MYASTHENIA GRAVIS.

Myasthenia gravis is a disease which is characterised by a weakness of certain of the voluntary muscles of the body which is slow in developing, and has as a prominent feature, a marked tendency to fluctuate in severity from day to day or from week to week, or even to disappear for months, only to appear again.

There are no sensory symptoms. The sexes are equally affected, the average age of onset for men is thirty-five, for women twenty-four.[4]

Owing to the rapid tiring of muscles there is difficulty with

[1] Osler's "System of Med.," 1915, v., 224.
[2] *Beiträg. z. path. u. z. allgem.*, xx., No. 11.
[3] *Amer. J. of Med. Sci.*, 1899, cxvii., 265.
[4] Campbell and Bramwell, *Brain*, 1900, xxiii., 279.

speech, mastication and swallowing. The levator palpebræ and other external muscles of the eye are often early involved, the intrinsic muscles escaping.

Thus one of the earliest signs of the disease may be ptosis on one or both sides, diplopia from involvement of the recti or oblique muscles, or lagophthalmos from weakness of the orbicularis. The ptosis or diplopia may be marked in the morning, much less by mid-day, and conspicuous again by night. The muscles show the myasthenic electrical reaction, *i.e.*, they are rapidly exhausted by the faradic form of stimulation, but are little affected by the galvanic.

The condition may progress slowly for many years, the manifestations which at first were partial and temporary, becoming complete and permanent.

MYOTONIA ATROPHICA.

Myotonia atrophica is a familial and hereditary disease, the characteristic features of which are weakness of the facial muscles, atrophy of the vasti of the thighs and dorsiflexors of the feet, and a slow relaxation of certain muscles after contraction (Batten and Gibb).[1] In addition, the subjects of this disease are especially prone to the early development of cataract, a point which distinguishes it from any other form of myopathy. Thus Greenfield [2] reports thirteen cases, of whom eight had cataract. Fearnsides [3] reports the case of a woman who had been operated on for double cataract at the age of thirty-one, and of whose family six others had developed cataract before the age of forty. Three of these showed no evidence of myopathy.

The cataracts are in no way distinctive except in the early age—between twenty and forty—at which they are developed, and it seems from Fearnside's cases that for a long time they may remain the only manifestation of the disease.

[1] *Brain*, 1909, xxxii., 187.
[2] *Rev. of. Neurol. and Psych.*, 1911, ix., 170.
[3] *Rev. of Neurol. and Psych.*, 1915, xiii., 312.

CHAPTER IV

Renal disease—Gout—Diabetes—Graves' disease—Disease of the pituitary body—Infantile scurvy—Keratomalacia.

RENAL RETINITIS.

This term is used to embrace those changes in the retina which indicate some disease of the kidney; it seems to be more appropriate than the term albuminuric retinitis, since the causes of albuminuria are so diverse and are not necessarily located in the kidney.

The ophthalmoscopic appearances are very characteristic, but are not entirely pathognomonic, for there a number of conditions, some of them confined to the eye, which closely simulate the retinitis of kidney disease.

Statistical.—The General Incidence of Retinitis.—The incidence of retinitis in kidney disease will depend very largely upon the stage at which the examination is made, and this accounts for discrepancies amongst different authors.

It is clear that if the retina is examined at the earliest stage of nephritis, the incidence of retinitis will be *nil*, whereas, if in a series of cases the examination be made immediately before death, the incidence is very high.

Most of the figures which are given by authors are compiled from patients in whom the disease of the kidney had attained such a degree as to render treatment within the wards of a hospital advisable, *i.e.*, they have been at least somewhat advanced cases. On these lines I have notes of 102 cases which I have examined; many of them on several occasions; from this number are excluded acute nephritis, trench nephritis, pregnancy cases, arterio-sclerotic cases, and cases in which detachment of the retina has developed.

Of these 102 cases, thirty-four had retinitis and sixty-eight had it not, *i.e.*, it was present in one-third of those cases of

nephritis in which the disease had attained a degree sufficiently advanced, to render in-patient treatment imperative or advisable.

Miles Miley's figures arrived at in a similar manner [1] are in close agreement with these; he found fifty-two cases amongst 166 patients with nephritis. Elschnig,[2] however, found forty-three cases only amongst 199 patients. Herringham [3] in patients under forty years of age, found twenty-six cases of retinitis amongst forty-six patients.

Incidence in the Different Forms of Nephritis.—A primary difficulty arises from the fact, that as pointed out by Herringham, it is often not possible, either clinically or histologically, to draw a sharp line of distinction between the different types of nephritis; at the same time certain broad statements can be affirmed.

Acute Nephritis.—It is generally agreed that if pregnancy cases are excluded, the presence of retinitis implies a nephritis of considerable standing; it is believed, however, by some, that it may arise occasionally in a primary acute nephritis; thus West [4] maintains that it is not rare in this condition. Sir Wilmot Herringham states: "Retinitis albuminurica has been said to occur in acute cases, but the reports are unconvincing. As a practical rule its existence is a proof that the disease is of long standing."

In general my own experience is in accord with Herringham's views if care be taken to exclude those cases in which an acute exacerbation of the chronic disease simulates a primary acute nephritis. I have notes of thirty-four cases only of primary acute nephritis, but I have examined many more than this, and the most I have been able to discover has been a small hæmorrhage in one case, and in three the disc had an indefinite hazy appearance such as one is in the habit of attributing to œdema, but which, at the same time, it is difficult to be sure is beyond physiological limits.

In the early days of the war I examined the fundi of 119

[1] *Trans. Ophth. Soc. U.K.*, viii., 1888, 134.
[2] *Wiener med. Wochens*, 1904, 494.
[3] "Kidney Diseases," London, 1912, 164.
[4] Lettsomian Lectures, 1900; *Lancet*, February, 1916, i., 372.

consecutive cases of soldiers suffering from "trench nephritis," *i.e.*, a primary acute nephritis.[1] Of these men five either had retinitis or developed it whilst they were under observation, and in only one of them was there any discoverable suspicion that he was previously the subject of chronic nephritis. The interval between the onset of the symptoms of nephritis and of the retinitis varied from seven to thirteen weeks, in one case the date of the onset of symptoms was precisely known, and the actual onset of the retinitis was seen to commence nine weeks later, whilst he was in hospital.

Whether these cases are considered to have persisted long enough to be called chronic nephritis as they probably became, or whether they should rather be labelled acute, I do not know; but if the latter view is taken, it is clear that the question as to whether retinitis occurs in acute nephritis must be answered in the affirmative as regards this particular variety of the disease, and probably also in pregnancy cases.

Chronic Parenchymatous Nephritis.—There is a consensus of opinion that retinitis is not common in this form of the disease.

Of fifty cases in patients under the age of twenty-one examined by Nettleship [2] seven only had retinitis.

Of twenty-three fatal cases of my own in which a definite differential diagnosis of chronic parenchymatous nephritis was made, seven had retinitis.

Chronic Interstitial Nephritis.—In this form of nephritis retinitis is frequent, if the period of examination extends to the end of the patient's life.

Of my own cases there were forty-four in which an unqualified diagnosis of chronic interstitial nephritis was made by the physician, and of these exactly one-half had some degree of retinitis, and four besides had retinal hæmorrhages only. Of eighty cases under the age of twenty-one examined by Nettleship [2] thirty-one had either retinitis or multiple hæmorrhages.

I am convinced that very few patients die in uræmia without changes in the eye grounds. Thus I have collected twenty

[1] *Lancet*, 1915, ii., 1348.
[2] *Royal London Ophth. Hosp. Reports*, 1906, xvi., 3.

cases which I had examined ophthalmoscopically at St. Bartholomew's Hospital, who afterwards died with a clinical diagnosis of uræmia, and in whom post-mortem findings were in accord with the clinical diagnosis in every case; in eight of them a detailed report of the microscopic appearances of the kidneys was available. Twelve were males and eight females, the average age of the males was thirty-seven, that of the females was forty-three, the average weight of the hearts was 18 ounces, the average systolic blood pressure was 202·5 mm., and the average weight of the kidneys together was 8 ounces. Of these twenty cases nineteen had retinitis, and the one remaining was last examined three weeks before death.

Sex Incidence.—The sexes are equally liable to retinal disease, but since chronic nephritis is about twice as common in adult men as in adult women so also is retinitis about twice as frequent, as is shown by the following figures :—

	Males.	Females.
Nettleship	56 ..	30 [1]
Miles Miley	38 ..	13 [2]
Bull	56 ..	47 [3]
Foster Moore . . .	63 ..	39

In younger patients, however, the sex incidence of nephritis is reversed, for Nettleship [4] found that of fifty-one cases of chronic interstitial nephritis in children under the age of thirteen, 30 per cent. were males and 70 per cent. females, and correspondingly retinitis becomes more frequent absolutely in females.

Age Incidence.—The youngest in whom I have found a record of renal retinitis is in a female child of five reported by Bull.

Nettleship records two aged seven, three aged eight; Herringham one aged seven.

I have seen it in a child of seven whose blood pressure was

[1] *Royal London Ophth. Hosp. Reports*, 1903, xv., 327.
[2] *Trans. Oph. Soc. U.K.*, 1888, viii., 134.
[3] *Trans. Amer. Op. Soc.*, 1886, iv., 185.
[4] *Royal London Ophth. Hosp. Reports*, 1906, xvi., 5.

260 mm., and in another child of the same age with a blood pressure of 240.

Of my cases the average age of those with retinitis was 37·5, and of those without retinitis 31 ; 64 per cent. of Nettleship's and 88 per cent. of Miles Miley's patients were between the ages of thirty and sixty.

Prognostic Significance.—There is no doubt, that if arterio-sclerotic, pregnancy, and trench nephritis cases be excluded, the long-accepted formula, that patients seldom live so long as two years after the discovery of retinitis, is true.

The prognosis is slightly less serious in private than in hospital patients.

Belt [1] found that of 419 patients, 6 per cent. lived longer than two years, and that 65 per cent. died within a year. Miley found in forty-five cases that the average duration of life from the time of discovery of the retinitis was four months. Bull [2] found that of 103 patients, eighty-six were dead ; and of these eighty-six, seventy-five died within two years, four were alive four years later, one six years, and one seven years later. And of twenty-four patients of Nettleship's under the age of twenty-one, one only lived longer than two years.

The prognosis is no less grave in children than in adults; indeed it is stated that in elderly patients the presence of retinitis implies a less grave prognosis than in young patients. This statement, however, is probably based on the inclusion of cases of arterio-sclerotic retinitis with the true renal cases.

The man from whom Figs. 50 and 51 (pp. 151 and 153) were made was first seen by me in May, 1913, with severe renal retinitis, a detachment of each retina, and a blood pressure of 215 mm. In 1915 he was exhibited at the Congress of the Ophthalmological Society of the United Kingdom [3] as showing considerable subsidence of retinitis and complete disappearance of the retinal detachments. He worked hard in a small arms factory during the war, and in June, 1920, was still in full work, and expressed himself as feeling very well. He had marked

[1] *Amer. Med. Ass.*, 1895, xxv., 735.
[2] *Trans. Amer. Ophth. Soc.*, 1886, iv., 190.
[3] *Trans. Ophth. Soc. U.K.*, 1915, xxxv., 159.

secondary retinal and nerve atrophy, albuminuria, and a systolic blood pressure of 260 mm. He died in hospital in August, 1920, in uræmia without a recurrence of retinitis (*vide infra*). Thus he lived in what he called good health, for seven years and three months after the development of so severe a retinitis as to cause retinal detachment in each eye.

The Relation of Blood Pressure to the Development of Retinitis.—As the renal disease progresses in severity, it is to be expected that so also will the concomitant signs and lesions increase, so that the more advanced the disease, the higher in general will be the blood pressure, and the greater the incidence of retinitis.

In sixty-eight of my cases of nephritis the systolic blood pressure is recorded, thus :—

> Of twenty-three patients with retinitis the average systolic blood pressure was 211 mm., and in six cases only was it less than 200 ;
>
> Whilst of forty-five patients without retinitis the average systolic blood pressure was 150, and in nine only did it exceed 160 mm.

And, again, of seventy-five soldiers with trench nephritis the average blood pressure of seventy with normal fundi was 143 mm., whilst in five in whom retinitis developed, it was 180 mm.

Thus it is very unusual to meet with retinitis except in the presence of a considerably increased blood pressure, but retinitis is often absent though the blood pressure is greatly raised.

The Retinitis of Pregnancy.—It is freely recognised that when retinitis occurs in association with the nephritis of pregnancy, the patient not being the subject of an antecedent chronic nephritis, it conveys a much less grave prognosis than in chronic nephritis in general.

Not only may the patient live for many years, but the retinitis may become completely resolved and leave very little ophthalmoscopic residue, and the sight is often in large measure restored.

Statistical.—Nettleship [1] followed up twenty-two cases of the condition for many years, and of them one only was known to have died within two years; four were known to have died three-and-a-quarter, four-and-a-half, seven, and seven, years later, and six others were known to be alive for periods ranging up to nine years.

Retinitis does not as a rule recur in future pregnancies where it has once been present and subsided.

It most often develops after several pregnancies though it may occur at the first; thus amongst nineteen cases it occurred at or after the fifth pregnancy in fourteen.

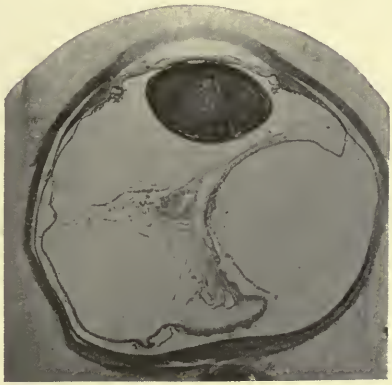


Fig. 41.—To show a large globular retinal detachment in a case of renal retinitis from a case of nephritis in pregnancy. A similar detachment was present in the other eye.

In three of the cases which occurred during later pregnancies, the patients were seen after eleven, thirteen, and twenty-four years, and had had no recurrence of eye symptoms.

It is suggested by Semple [2] that retinitis in pregnancy is not directly related to the kidney disease, but that it, and the involvement of the kidney, and liver, and other organs, are due to a common toxæmia, and consequently that one or other of these organs, the eye for instance, may be involved, the other tissues escaping.

Thus Posey and Hirst [3] report a case with constitutional symptoms, with normal urine but with very extensive retinitis; an early abortion procured complete recovery of vision; Semple reports a similar case.

In summing up the characteristics of the retinitis of pregnancy, Semple remarks that it differs from other forms of renal

[1] *Royal Lond. Ophth. Hosp.* (*Moorfields*) *Reports*, 1903, xv., 322.
[2] *Trans. Amer. Ophth. Soc.*, 1909–11, xii., 817.
[3] *Jour. Amer. Med. Ass.*, 1908, l., 865.

retinitis; he says: "The sudden onset, the tremendous exudation into the retina, the equally sudden cessation on removal of the cause if done promptly enough, the subsequent and complete restitution of visual acuity, all are in marked contrast to the usual course of retinitis of other forms of Bright's disease."

The retinal changes in these pregnancy cases are usually very severe, with copious exudate and œdema in the retinal tissues, and detachment of the retina occurs from the pouring out of serum into the subretinal space, in a much larger proportion of them than in other forms of nephritis (Fig. 41).

Thus, of forty-four cases of detachment of the retina in renal retinitis [1] which I was able to collect, thirty occurred in women, and of these seventeen were associated with pregnancy. And whereas ten of these seventeen are known to have recovered, temporarily, of the thirteen unassociated with pregnancy eleven are known to have died, and two only recovered for the time being.

In addition to the loss of sight which results from the visible morbid changes in the retina which are included under the term of the retinitis of pregnancy, marked visual defects may occur during pregnancy, parturition, or the puerperium without discoverable retinal disease, and whilst they are often associated with signs of eclampsia, they are not necessarily so connected.

Adam [2] found visual disturbances in 50 per cent. of cases of eclampsia.

The loss of sight which is rapid and complete, may last from a few hours up to several weeks, but recovery is complete.

The fundi, except for an occasional flame-shaped hæmorrhage, are normal, and the pupils remain active to light stimulus.

These cases have been examined by Stephenson and Herringham,[3] who show that they are not dependent upon uræmia, although they have often been confused with it.

They are usually associated with scanty urine which contains albumen, blood, and casts; with œdema, and headaches.

[1] Foster Moore, *Royal Lond. Ophth. Hosp. Reports*, 1916, xx., 293.
[2] *Monats. f. Geburts. u. Gynäk.*, 1914, xxxix., 808.
[3] "*Ophthalmoscope*," 1910, viii., 168.

It has been suggested [1] that the immediate cause is an exhaustion of the cerebral visual centres, which similarly, when other parts of the brain cortex are affected, results in transient aphasia, hemiparesis, etc.

In some cases of nephritis, especially where uræmia is present or imminent, exophthalmos occurs. I have seen a case in which it was well marked and associated with pain behind the eyeballs and limitation of movement of the eyes; the fundi at first were normal, but eleven weeks later, conspicuous pigmentary proliferation was seen with the ophthalmoscope, marking out the course of the choroidal vessels, it seemed as if toxins in the orbital tissues had produced œdema of them and pain and limitation of movement of the eyes, and had involved the posterior ciliary arteries so as to cause marked proliferation of pigment in their course.

The occurrence of exophthalmos and of some other ocular signs in chronic nephritis has been especially studied by Barker and Hanes,[2] who insist upon their frequency. They state that of thirty-three consecutive cases seen in the Johns Hopkins Hospital, exophthalmos was present in 48·4 per cent., and that of seven consecutive fatal cases exophthalmos was an obvious sign in all. They say, in addition, that Graefe's sign, Stellwag's sign, Mœbius' sign, and inequality of the pupils are all frequently seen.

Ophthalmoscopic Changes in General.—These are divisible into three kinds, exudates, hæmorrhages, and œdema, and in cases of any marked extent all of these will be present.

There is no constancy in the order in which they appear. Sometimes the first sign is a retinal hæmorrhage, at other times swelling of the nerve head, or the presence of one or other variety of retinal exudate.

Some degree of œdema of the retina is probably present in all cases, but the ophthalmoscopic evidences of it are very indefinite, and unless the œdema is well marked, it is not possible to diagnose its presence or absence with any certainty by means of the ophthalmoscope, and were it not for histological

[1] Garrod and Thursfield, "Children's Diseases," 1913, 729.
[2] *Amer. Jour. of Med. Sci.*, 1909, cxxxviii., 669.

evidence, and one's general knowledge of such pathological processes, one would be left in doubt as to its occurrence except in a few cases.

The microscope, however, demonstrates how marked the œdema may be, and in some cases it may transgress the limiting membranes of the retina and produce a detachment of this membrane by collecting in the subretinal space (Fig. 41 and p. 150).

Hæmorrhages.—Retinal hæmorrhages are always present, and are most frequent and largest in the central regions.

They are seldom very large, are usually, though by no means always, of the flame-shaped type, and undergo changes similar to like hæmorrhages from other causes (*vide* p. 34).

So long as active changes are present hæmorrhages will be found, their presence being maintained by the continual occurrence of fresh ones as the older ones become absorbed, but as a stage of complete subsidence is reached if the patient survives sufficiently long, so the hæmorrhages completely disappear.

Exudates.—Any local degenerative process in the retina will impair its local transparency, and so will appear to the ophthalmoscope as a white spot or patch, and similarly areas of exudate amongst the retinal tissues are seen as white spots or areas; indeed, pathological processes of most diverse origin, will produce spots or areas in the retina which are white in colour; they differ, however, as regards their size, texture, arrangement and progress.

A number of white areas of differing appearance occur in the retina in renal retinitis and can be seen to undergo various metamorphoses under observation.

(1) **Cotton Wool Patches.**—Under this descriptive head are included certain soft-edged, woolly-looking patches of considerable size, which occur around the central regions of the retina. They are often partly fringed or overlain by blood, and may obscure the retinal vessels; evidence of retinal œdema may be seen around them.

They occur especially in those cases in which the toxic element of nephritis is prominent. They are often copious,

and are seen in their characteristic form in pregnancy cases and in parenchymatous nephritis, but occur in other forms of the disease. It is in the presence of these patches that œdema is most marked, and that, therefore, retinal detachment is most likely to occur. The separate patches may, by confluence, give rise to large areas of retinal infiltration.

Histologically, this exudate is represented by an extensive

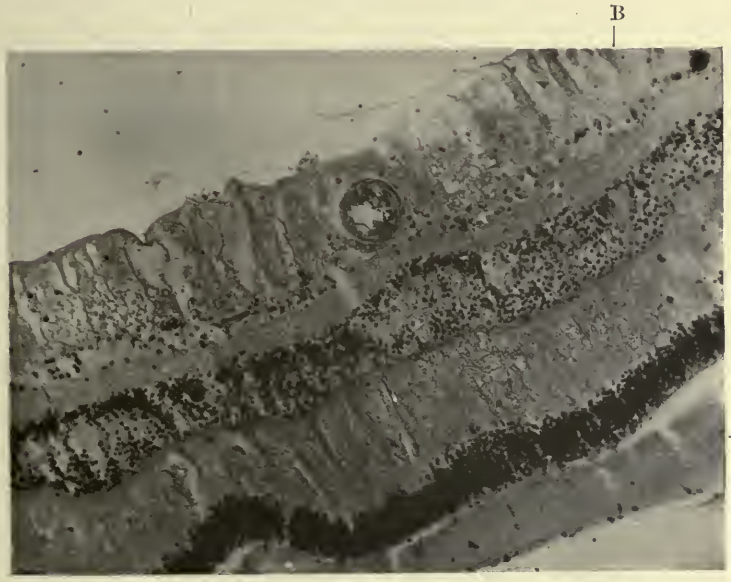


FIG. 42.—Section through the retina in a case of severe retinitis in chronic parenchymatous nephritis. All the layers of the retina are profusely infiltrated by œdema and fibrinous exudate. *A*. Layer of rods and cones. *B*. Nerve fibre layer.

infiltration of the retinal layers by a fine fibrinous mesh work, which stains well with Weigert's anilin-gentian-violet stain (Fig. 42). It often occurs in flask-like spaces in Henle's layer, but may infiltrate all the retinal tissues.

Three stages are described by Semple [1] in the metamorphosis of this exudate, a view which is supported by Rochon Duvigneaud.[2]

[1] *Trans. Amer. Ophth. Soc.*, 1909–11, xii., 817.
[2] *Soc. franç. d'Ophthalmol.*, 1912, xxix., 6.

(1) Network of fibrin (Fig. 42).
(2) The masses lose their fine fibrillar appearance and cease to stain by Weigert's stain.
(3) All fibrillar appearance is lost and the exudate takes on the form of masses of hyalin material (Fig. 43).

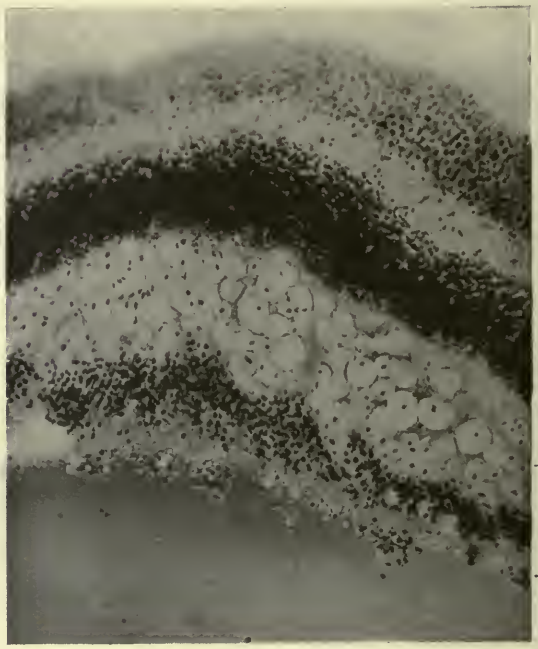


Fig. 43.—A section through the retina near the yellow spot in a case of renal retinitis in which a star figure was present. There has been a large amount of hyaline exudate in Henle's layer which has been very nearly removed by the large globular phagocytic cells; a little still remains between these cells. The rods and cones appear to have completely degenerated. *A*. Rod and cone layer. *B*. Henle's layer with exudate and phagocytic cells.

After a time conspicuous large globular phagocytic cells appear and apply themselves to the hyalin masses and bring about their absorption (Fig. 43). The cells themselves become filled with a lipoid material, and some of them are densely stained by osmic acid (Figs. 44 and 45). It is evident that fat is formed in the retina in some cases at least. Semple could

find no evidence of fat in his cases. He, however, emphasises the fact that they were early cases. No fat was found by Litten.[1] On the other hand, fat was found by Leber,[2] Lauber and Adamük,[3] Rochon Duvigneaud and Mawas,[4] and Ginsberg.[5]

The individual "cotton wool" patches can be seen with the ophthalmoscope to disappear in course of time, although at the

FIG. 44.—A section through the retina of a young woman who died of chronic interstitial nephritis and in whom a well-marked star figure was present in the retina. Many large phagocytic cells are present, which are full of fat stained by osmic acid; the cells are almost entirely confined to Henle's layer, three only transgressing its limits, the greater number are in rather close apposition with the external limiting membrane. *A* marks the nerve fibre layer, and *B* the rod and cone layer.

same time fresh areas may be developing. As a rule they simply fade away and leave no trace behind. The larger the mass the longer does it take to become absorbed. I have seen a small patch completely disappear in fourteen days; I have also seen

[1] *Münch. Med. Wochensch.*, 1903, l., 391.
[2] v. Graefe's *Archiv. f. Ophth.*, 1909, lxx., 20.
[3] v. Graefe's *Archiv. f. Ophth.*, 1909, lxxi., 429.
[4] *Mem. et Bull. de la Soc. Franc. d'Ophth.*, 1912, xxix., 6.
[5] v. Graefe's *Archiv. für Ophth.*, 1912, lxxxii., I.

a larger solid-looking area remain comparatively little changed after seven months (Fig. 53, p. 157).

The Star Figure.—The most striking form of exudate is that which occurs in lines radiating from the region of the yellow spot giving rise to the familiar star figure.

Not infrequently the first sign of retinitis is in the form of

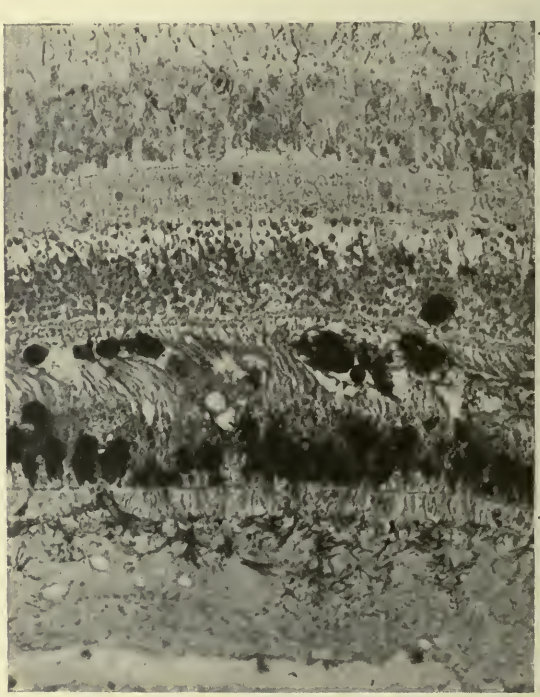


Fig. 45.—From the same patient as Fig. 44 more highly magnified. A well-developed star figure was present. Notice the distribution of the large fat-containing phagocytic cells. *A* marks the nerve fibre layer, *B* the layer of ganglion cells, and *C* the rod and cone layer.

one or more rod-like or oat-shaped dots along a line of radius from the yellow spot. These spots are added to until in the course of some weeks the fully-formed star is seen (Fig. 46, p. 145).

In some cases, previous to the development of the star, a complete figure of very fine lines may be seen radiating all round from the yellow spot as a centre.

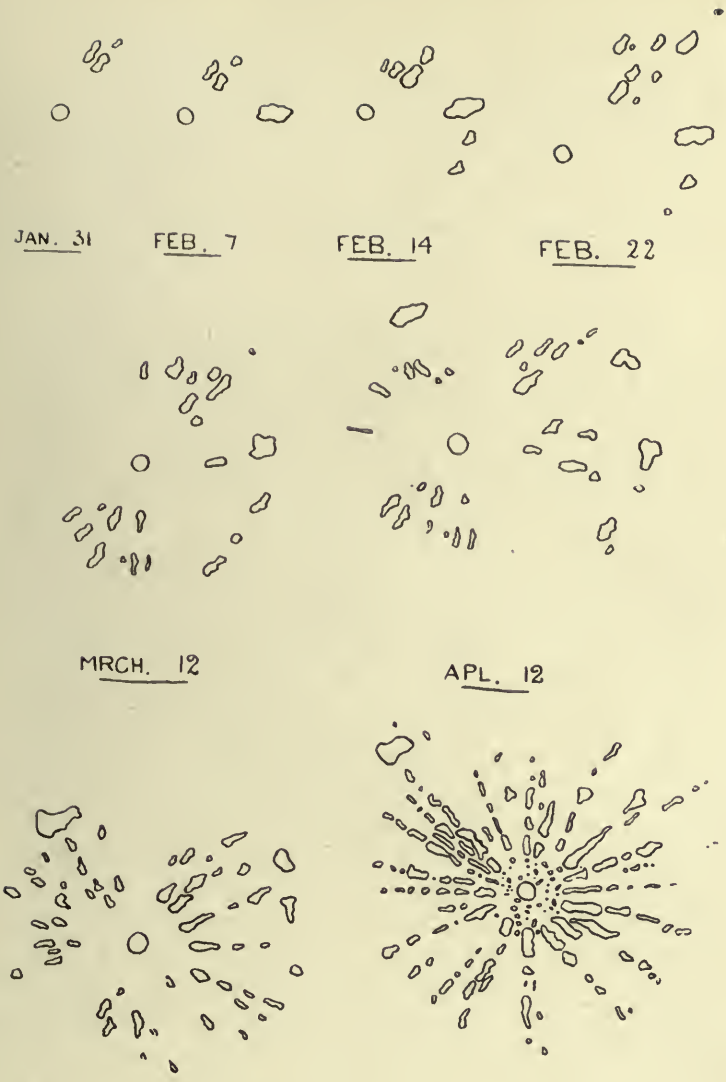


FIG. 46.—Showing the slow development of a star figure in a girl of twenty-one under the care of Dr. James Calvert; she had had symptoms of nephritis for two years. Except in the last figure, an endeavour was made to represent every individual spot of exudate that was visible. The dates are those at which each drawing was made. The small circle in each figure represents the position of the yellow spot.

These lines have the appearance of refractile lines, or lines of tension, and suggest a sort of scaffolding around which a star figure may be laid down; they extend outwards beyond the limits of the star which follows.

I have watched the development of a star figure from the time when two dots only were present till a well-developed figure was seen in the course of twelve weeks (Fig. 46).

I have seen the star form and its identity afterwards become lost in a profusion of exudate in the course of seven weeks, and more than once I have watched one completely disappear in the course of a good many months—nine in one case—and leave no trace behind of its former presence.

This very striking formation is more often seen in renal retinitis than in any other condition, but it is by no means pathognomonic of nephritis, for it is seen in a number of very diverse forms of retinal disease, *e.g.*, papillœdema, embolism of the retinal artery, syphilitic retinitis, thrombosis of the retinal veins, etc.

Unless the actual fovea is the site of exudation, the vision is not necessarily impaired.

With regard to the explanation of the formation of this striking figure, it is usually attributed to the arrangement of the fibres in Henle's layer, that in fact it has an anatomical basis.

Perhaps one may be permitted to put forward tentatively a physical cause as the basis. As has been mentioned, it is by no means rare for the star figure to be preceded by closely packed fine lines radiating outwards from the macula, or in the presence of a star these lines may be seen to extend well beyond it all round, and as has been stated, they suggest a scaffolding around which the figure is laid down. These lines are so fine, so strictly linear, and so regular in arrangement, as to suggest most strongly lines of tension in an œdematous retina; they certainly have no organic basis. It suggests itself, that were the yellow spot held down to the underlying pigment layer, the rest of the retina being free, on the development of retinal œdema at the posterior pole of the eye, these lines of tension would tend to form. I know of no histological evidence that any such adhesion is present, I therefore examined thirty-seven

eyes in the post-mortem room. In thirty-three of these I could find no evidence of adhesion at this spot, in four it seemed to be slightly adherent, and it was common to find with the sliding of the retina on the underlying pigment layer, that the retina became puckered at the macula as if it were held here.

Some support for this suggestion may be derived from the

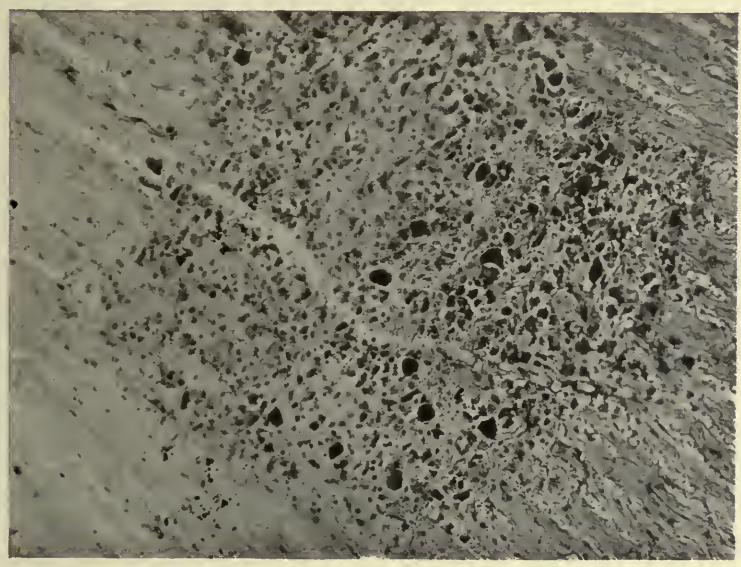


FIG. 47.—A section in a plane parallel with the surface of the retina passing through the ganglion cell layer in the central part and through the nerve fibre layer around. The section was immediately to one side of the yellow spot, over an area where a well-developed star figure was present. It shows the entire absence of exudate in this layer, and no change other than, perhaps, some degeneration in some of the ganglion cells. Sections at a deeper level over this area showed the presence of copious exudate.

fact, that it is not rare for a star arrangement of exudate to develop in cases of papillœdema, and in my experience it is seldom a complete star that is formed, but a fan-shaped figure. In this latter case the fan is always placed between the disc and the yellow spot, with its apex towards the latter. That is, the fan figure is formed in that portion of the retina to which the œdema spreads from the nerve head, and is laid down along

supposed lines of tension which run between two fixed points, the disc and the yellow spot.

Hulke believed the star was due to fatty transformation of hyperalbuminous fluid and fibrogenous serum. Nuel attributes it to the presence of globules of an albuminoid nature in Henle's layer, and Rochon Duvigneaud suggests that it is caused by the presence of fibrinous clots in the nerve fibre layer and to the radial disposition of the nerve fibres around the macula. (See, however, Fig. 47.)

It is probable that the exudate itself is of a hyaline type (Figs. 43 and 45), and that exudate of a fibrinous nature is not kept within such bounds as to form a star figure (Fig. 42, p. 141).

Other white patches are produced by degenerations in the nerve fibre layer resulting in patches of varicose nerve fibres and cytoid bodies (Fig. 48). Ginsberg looks upon these as one of the chief sources of the white patches. They are seen with the ophthalmoscope as white areas with harder edges than the fibrinous patches, they are slower to disappear, and may show cholesterin crystals within them. They occur in a number of retinal degenerations, and are by no means limited to renal retinitis.

Semple believes that degeneration of the retinal ganglion cells is responsible for some of the white areas.

Vascular Changes.—The changes in the veins are not important, and whilst in long-standing cases sclerosis of the arteries occurs, the arterial disease is believed by many to be of a secondary nature.

Thus Semple, Schieck,[1] Opin and Rochon Duvigneaud,[2] and Lauber and Adamük, all look upon the changes in the vessels as of secondary importance in the production of the retinal changes, the changes being dependent upon toxins in the blood.

Semple points out that there are cases of marked involvement of the retina in Bright's disease where the retinal and choroidal vessels are practically normal. He believes that the retinal disease is due to toxins in the blood acting on the retinal tissues, before it affects the vessels to an extent histologically demonstrable.

[1] Ophthalmol. Gesellsch. Heidelberg, 1907, 77.
[2] *J. de physiol. et de path.*, 1903, v., 1081.

Papillœdema.—It is of considerable importance to have in mind, that whilst in any case of severe retinitis the optic disc is involved, yet at times a pure papillœdema may occur as a manifestation of renal disease. This papillœdema may be quite indistinguishable from that seen with a cerebral tumour, and whilst as time goes on exudates usually appear in the surrounding retina wide of the disc which make the nature of the case clear, I have seen two cases continue up to their death with a pure

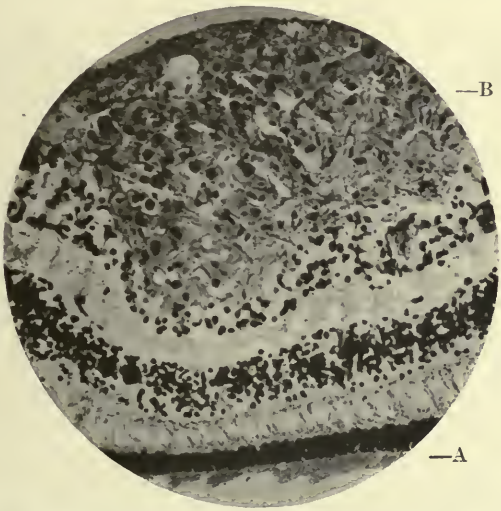


Fig. 48.—Section through the retina in a case of renal retinitis to show varicose nerve fibres in the nerve fibre layer, *B*. *A*. Rod and cone layer.

papillœdema, and without exudates in the retina around (Fig. 49).

I have once seen a well-marked unilateral papillœdema in renal disease. The patient, a woman, died in uræmia, a fact which was confirmed by post-mortem examination. As late as two days before her death the left disc was in a condition of well-marked papillœdema; it was indistinguishable from that seen with a cerebral tumour, whilst the other disc was quite normal in appearance.

It is obvious, seeing that headaches and vomiting are prominent features of both renal disease and of a cerebral tumour,

and that a pure papillœdema may occur in either, that a real difficulty may arise at times in distinguishing between these two conditions.

A further complication too is supplied by the fact that in a few cases, especially in young subjects, a partial star figure may develop in the papillœdema associated with a cerebral tumour.

My impression is that the prognosis is especially grave in these cases ; Ballantyne is of the same opinion.

Fig. 49.—A section through the optic disc to show œdematous swelling in a case of nephritis. Ophthalmoscopically it was a case of pure papillœdema with no exudates or hæmorrhages in the surrounding retina.

The blood pressure in four of my cases, including the two referred to, was 200, 245, 250, and 225.

Retinal Detachments.—To judge from published cases, detachment of the retina would seem to be a rare complication of renal retinitis ; this, however, is not the case if patients are examined right up to the time of their death. Thus I have published [1] thirteen cases which I was able to discover in the course of two-and-a-half years.

[1] *Royal London Ophth. Hosp.* (*Moorfields*) *Reports*, 1916, xx., 262.

They are most common in those cases in which the changes in the retina are most profuse, and are probably for this reason especially common in pregnancy cases (Fig. 41, p. 137). In so far as they are usually associated with severe retinal changes they indicate a bad prognosis, but many patients survive, and in this case the retinal detachments disappear.

Of forty-four cases (thirteen of my own and thirty-one collected cases) seventeen were associated with pregnancy, and of these, nine made a temporary recovery; whereas of the twenty-seven other cases, four only are known to have recovered, and seven are either not traced or are under observation.

FIG. 50.—A vertical section through the posterior part of the eye of a man, who, seven and a half years previously, had had so severe a renal retinitis as to produce a retinal detachment in each eye. The detachment of each eye, as seen ophthalmoscopically, disappeared about seven years before death, and there was no sort of residue of them in either eye on histological examination.

The detachments are due to effusion of fluid from the retina into the subretinal space. They are usually bilateral, globular, and involve the lower part of the retina (Fig. 41, p. 137). Many of the patients are the subject of widespread anasarca. I believe, however, that the detachments are due to the local changes in the retina, and are not an expression of the general œdema, for in spite of severe general œdema in many cases of nephritis, acute and chronic, I have never seen retinal detachment in the absence of retinitis, and this usually of a severe type. I have, however, once seen it in a case in which the retinal changes, apart from signs of œdema were

slight, and once also in a case of orthostatic albuminuria. Simon [1] has seen a similar case.

As already stated, recovery is usual if the patient survives (Fig. 50). I have seen the subretinal fluid completely absorbed within eight days of its discovery, and three days after the removal of twelve pints of ascitic fluid from the peritoneal cavity: this is the shortest time in which I have seen recovery occur.

Subjective Symptoms.—In some cases of retinitis subjective visual phenomena are marked. Objects like flowers or butterflies are not infrequently complained of; in other cases all objects are blue, or lights and patches of different colour are seen. Simon [2] points out the frequency of the failure to recognise yellow and blue tints.

Very extensive retinal changes may be present without the visual acuity being much affected so long as the macula is not involved.

The Subsidence of Retinitis.—In the ordinary course of the progress of retinitis, individual hæmorrhages and areas of woolly exudate become absorbed. Fresh hæmorrhages and exudates however, develop, and the net result is a gradual increase in both of these; accompanying these changes the retinal vessels become engorged and œdema of the retinal tissues occurs.

After a varying length of time subsidence sets in, and this is true whether the patient improves towards temporary recovery, or whether he gets progressively worse and dies, so that it may happen that at the time of death the retinitis has passed its acme and has begun to subside. I have seen this stage reached within nine weeks of the beginning of the retinitis in a young girl, and in eight weeks after the discovery of the star figure in a man of thirty-six. The progress of the changes is more rapid in the young.

The earliest indication that subsidence is beginning is a reduction in the size of the veins. During the progressive stage they are engorged, but as the retinitis begins to subside they

[1] *Klin. Monats. f. Augenheil.*, 1905, xliii., i, 221.
[2] *Centralblatt für prakt. Augenheil*, 1894, xviii., 132.

become smaller, till they are less than the normal; they develop white lines along them near the disc.

Another change is seen in the curves of the veins; these, instead of being full and even, tend to be somewhat angular or craggy, as if their previous distension had to some extent impaired their resilience.

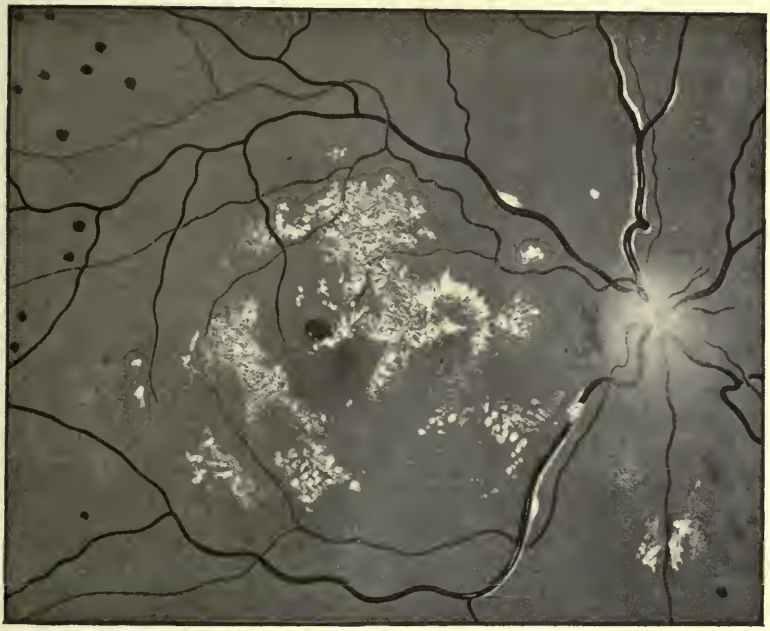


FIG. 51.—Shows a renal retinitis which is well on its way to subsidence, as evidenced by the pale secondary atrophic disc, the greatly attenuated vessels, especially the arteries, the sheathing of the veins, the powdery nature of the exudate, and the pigment spots. From a man of forty-six who had had so severe a retinitis as to produce a double detachment of the retina; he died in uræmia six years after the drawing was made.

Changes exactly corresponding with the foregoing also take place in the arteries, till ultimately they may be one-half or less of their normal diameter (Fig. 51).

The optic papilla, at first swollen and œdematous, with hæmorrhages and exudates on it or in its vicinity, later undergoes atrophy and becomes pale with hazy edges; it has the appearance of a secondary optic atrophy (Fig. 51).

The earliest of the patches of exudate to disappear are the "cotton wool" patches; the more solid-looking exudates are more permanent (Fig. 53, p. 157).

When subsidence is well advanced there will be found scattered irregularly over the central regions a very fine powdery white residue, which has no regular arrangement even though a star figure was previously present.

This fine powdery white residue is very characteristic of a subsided retinitis (Fig. 51).

Amongst it there may be a few more solid-looking spots or areas, perhaps with cholesterin crystals in them; these persist for a long time, as also do a few small scattered hæmorrhages, but if the patient survives, all the exudates and hæmorrhages disappear completely.

Pigmentary Changes.—After subsidence, some pigmentary disturbance is almost always to be seen; it is mostly of an entirely irregular type, and is in part due to the migration of pigment into subretinal exudate, which exudate is subsequently absorbed.

In addition to this, characteristic round or angular pigment spots may appear, especially towards the periphery. They are rather uniform in size, shape, and texture (Fig. 51, p. 153) and have been figured by Liebreich,[1] and are described by Nettleship.[2] They are never plentiful, and occur in loose groups. I have not seen them disappear and it seems unlikely that they would do so. They are composed of wart-like proliferations of the pigment epithelium (Fig. 52).

On differing Types of Renal Retinitis.—It is of some importance to inquire whether there are different forms of retinitis associated with different varieties of kidney disease, or, short of this, whether there are features of the retinitis which are suggestive of one or other of the factors which are especially concerned in nephritis.

I believe the general feeling of ophthalmic surgeons is, that a fundus which shows numerous cotton-wool patches, with œdema and perhaps a retinal detachment, implies, not a diffe-

[1] *Atlas Tab.*, ix., Figs. 1 and 2.
[2] *Trans. Ophth. Soc. U.K.*, 1899, xix., 63.

rent stage of disease, but a disease of a different type from that which is implied by a fundus showing marked vascular change, with more numerous flame-shaped hæmorrhages, little œdema, a star figure composed of discrete dots, and no " cotton-wool " patches.

It will, however, be agreed that there are many intermediate cases which it is impossible to classify on these lines.

It is believed by many that there are two outstanding factors

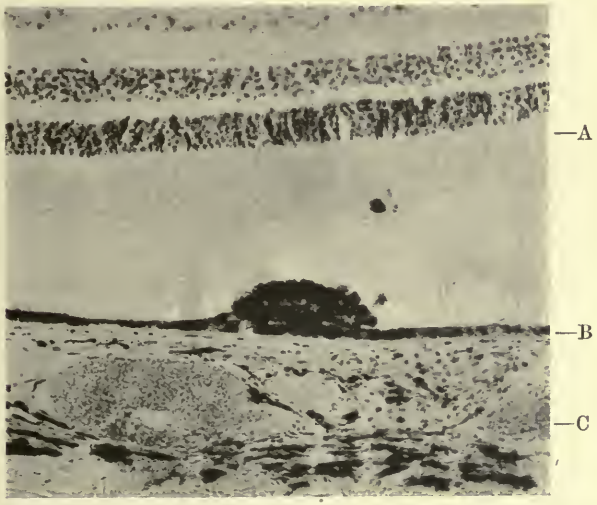


FIG. 52.—Showing a wart-like overgrowth of the retinal pigment epithelium in a case of renal retinitis. (See also Fig. 51.) *A*. Rod and cone layer. *B*. Pigment epithelium. *C*. Choroid.

concerned in nephritis, a toxic and a vascular, and that these are of varying importance in the different types; that in parenchymatous nephritis the toxic element prevails and the vascular is less important, in the arterio-sclerotic kidney the whole disease is primarily vascular in origin, and between these two extremes is every grade of kidney disease, and the secondary contracted kidney of Herringham is in some sense intermediate between these two forms.

I believe cotton-wool patches, with the accompanying œdema and few hæmorrhages, are a product of the toxic element of the disease; that the small rather scanty discrete hard-edged dots,

which may or may not form a star figure and are described under arterio-sclerotic retinitis, are, in combination with evidences of retinal arterio-sclerosis, a pure product of the vascular disease, and that intermediately is the coarser textured star figure, with rather numerous flame-shaped hæmorrhages, and a few larger soft-edged areas, which are associated with a secondary contracted kidney.

The difference in ophthalmoscopic appearances between arterio-sclerotic retinitis, and the retinitis associated with parenchymatous nephritis is so great that it would not be imagined that they were in any way related.

I feel confident, that in no inconsiderable number of cases the ophthalmoscopic appearances of renal retinitis are sufficiently distinctive to indicate the type of kidney disease which is present, but in many cases no such deduction is possible, and one may remember that the clinical findings of the physician in the same way are not always conclusive in this direction.

The retinal changes associated with a small white kidney are perhaps worthy of special mention.

This form of disease occurs in the young, and is characterised by a very high blood pressure and absence of œdema.

The retinal changes are seldom, if ever, absent; they are severe in degree, and a particularly striking star figure of rather coarse texture is generally seen. Rutson James [1] reports twenty-four cases in detail.

Recurrence of Renal Retinitis.—When an eye has been the subject of retinitis, and this has completely subsided, does it recur in a subsequent recrudescence of the nephritis which proves fatal?

It would be expected, *à priori*, that, unless the retina was completely atrophied—which probably never occurs from retinitis alone—that retinitis would again develop, but in a modified form; recurrent hæmorrhages certainly take place. I have watched several patients for a number of years after subsidence of retinitis, and have not seen any evidence of recurrence of it.

[1] *Ophth. Review*, 1913, xxxii., 164.

Knies [1] mentions a case of hæmorrhagic retinitis in one eye, the other eye, which was blind from a previous retro-bulbar neuritis, being spared.

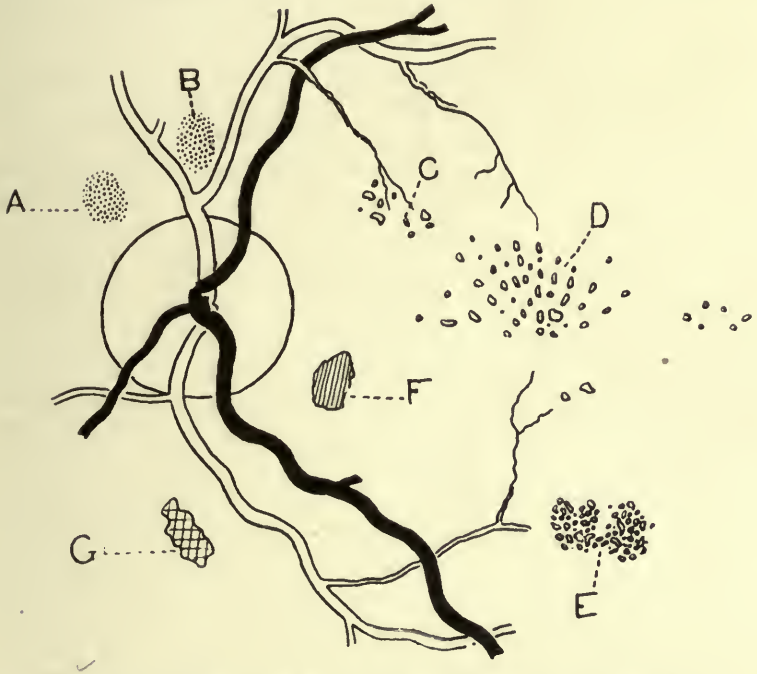


Fig. 53.—A composite diagram to indicate the length of time required for the disappearance of different types of retinal exudate in renal or arterio-sclerotic retinitis. The patches of different types of exudate have been collected from their proper notes and incorporated here. The time given dates from the occasion when the patch was first seen. *A.* A small "cotton wool patch" which had completely disappeared in five weeks. *B.* A small "cotton wool patch" which had completely disappeared in two weeks. *C.* Discrete dots of exudate in arterio-sclerotic retinitis; no change in them could be appreciated at the end of eleven weeks. *D.* A partial star figure from a case of arterio-sclerotic retinitis. After thirty weeks two dots only were left, and there was no trace of the condition three years later. *E.* Almost conglomerate exudate: there were powdery remains seven months later. *F.* Rather solid-looking exudate: it had disappeared five weeks later. *G.* Solid-looking exudate with included cholesterin crystals: it was still present seven months later.

Nettleship [2] reports a case in which one eye only was affected, the unaffected eye being blind as a result of thrombosis of the

[1] "Eye in General Diseases," New York, 1895, 306.
[2] *Royal London Ophth. Hosp. Reports*, 1903, xv., 340.

central retinal artery ; a second pregnancy case, in which eye symptoms recurred, but there was no fresh retinitis ; and a third case, in which typical retinitis was present in the right eye, which had no refractive error, whilst the left eye seemed to be protected against its development from the fact that it was highly myopic. I have seen a similar case.

In the patient previously referred to (p. 135 and Fig. 51) a very extensive retinitis occurred, and, as has been explained, complete subsidence took place, leaving the retina and choroid in an atrophied condition. He was under my constant observation for seven years and three months, and died in hospital of uræmia—still under my observation—with a blood pressure of 240 mm. During the whole of this time there was never the slightest evidence of recurrence of the retinitis up to the day before his death, at which time he was last examined. I can feel no doubt that, but for the previous retinitis and consequent partial atrophy of the retina, he would not have died in the manner he did without retinitis having developed.

I believe that an antecedent disease of the eye grounds, whether it be renal retinitis or other morbid change, protects the eye against the development of renal retinitis, and, consequently, that a recurrence of the retinitis of renal disease is quite unusual ; I cannot, however, be sure that such protection is absolute, and it seems unlikely that it should be so.

URÆMIC AMAUROSIS.

In some cases of approaching uræmia loss of sight occurs. The characteristic symptoms are : the sudden onset and completeness of the blindness, the rapid and complete recovery, the absence of any corresponding changes in the retina, and the retention of the pupil reaction to light.

It is a striking fact that in some cases there are no prominent cerebral symptoms of uræmia, so that such patients may present themselves at the out-patient department of an eye clinic. Renal retinitis may or may not be present, and in the former case some care is necessary to avoid attributing blindness, which is, in fact, of uræmic origin, to the local morbid changes in the retinal

tissues, it will, however, be readily appreciated how disproportionate is the loss of sight to the local retinal changes.

The fact that the pupil reactions to light are retained suggests that the visual defect is located in the cerebral cortex.

Lardaceous Disease.—Of lardaceous disease Herringham says: "The heart does not hypertrophy, the blood pressure does not rise, and albuminuric retinitis does not occur."

Nettleship says that few cases have occurred, and that further observations are necessary.

I can only say that I have found entirely normal fundi in the few cases that I have examined.

GOUT.

So numerous are the manifestations attributed to that disorder of metabolism to which the term constitutional gout is applied, that it need cause no surprise to find that at different times, by different observers, a gouty form of many of the diseases of the eye has been described; and whilst so many forms of eye disease with cause unknown remain, it is not possible to deny that so protean a disease may at times be justly held responsible for some of them.

At the same time the evidence of causal relationship is frequently of the slenderest, and it would often seem less retrograde to uncover one's ignorance under so discredited a term as "idiopathic" than to apply a title which, too often, is but a placebo to the patient, and to the surgeon a self-deception.

In very few instances are there distinctive characteristics which enable one to diagnose a gouty origin for any disease of the eye.

Of the lesions whose relationship to this disease seem best attested the following may be mentioned:—

First, a group of cases which is associated with disease of the vessels has been described under terms such as "hæmorrhagic retinitis," "phlebitis," "venous thrombosis," phlebosclerosis," "arterio-sclerosis," etc., by Hutchinson,[1] Galezowski,[2] Spillman,[3] Bull, and many others; these have

[1] *Roy. Lond. Ophth. Hosp.* (*Moorfields*) *Reports*, 1873, iii., 315, 455.
[2] *Recueil d'Ophth.*, 1900, xxii., 65.
[3] *Gaz. hebd. de mèd.*, 1890, xxvii., 480.

already been dealt with under the head of vascular disease, without prejudice to the relationship of gout to them.

Iritis is seen not infrequently in patients at or beyond middle age in whom none of the more usual causes are found. In some such cases joint pains are complained of, and the condition is often attributed to gout.

Hutchinson [1] describes gouty iritis as occurring in two forms. One especially affects males in vigorous health past middle age; first one eye is affected, then the other, but seldom both together. The other form occurs most often in women, both eyes being commonly affected, and the ciliary body and choroid are frequently implicated. He states, that of 104 cases of iritis, a positive history of gout was obtained in eighteen, and in twenty-nine there was a positive history of gout in near relatives, *i.e.*, unequivocal gout in the big toe.

In other cases of persistently recurring iritis, cyclitis, and scleritis in middle-aged patients, in which corneal opacities and ciliary staphylomata often arise, Hutchinson says: "It is probable that in some cases the constitutional cause of this destructive and persisting disease is gout."

Conjunctivitis.—An obstinate form of recurrent conjunctivitis is recognised by many as associated with gout.

This was described by Hutchinson under the term of "hot eye." He speaks of it as a common phenomenon which attends quiet gout. It is characterised by short attacks of congestion which sometimes affects both eyes. The conjunctiva becomes red and the eyeball feels hot, and pricks as if sand were in it. It may last a few hours or a day or two, and not infrequently culminates in iritis.

Of other lesions it is greatly to be doubted whether gout ever produces the ophthalmoscopic signs of optic neuritis, or is responsible, except through the intermediation of vascular disease, for ocular paralysis.

Gowers [2] states, however, that spontaneous inflammation of nerve trunks and plexuses on one side only, and recurring after the age of thirty, are seldom due to any cause other than

[1] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1885, v., 9.
[2] *Med. Ophthalmoscopy*, 1904, 254.

gout. He believes that inflammation of the sheath of the optic nerve behind the eye is less common in ordinary gout than inflammation in the retina. As characteristic of these affections he gives the greater degree of disturbance of vision than corresponds with the visible changes in the optic discs, the tendency to irregular defects in the fields of vision, and the strong tendency for the other optic nerve to be affected by an independent symmetrical morbid process.

DIABETES.

Diabetic Retinitis.

Doubt has been expressed as to whether a retinitis due to diabetes alone ever occurs. The most weighty reason for doubting the existence of a pure diabetic retinitis is, that in young subjects, in whom the disease manifests itself in its most malignant form, and in whom the toxic elements are most prominent, retinitis never occurs.

A second reason which lends weight in the same direction is the fact, that it is usual to find albumen as well as sugar in the urine of patients with diabetic retinitis; and further, it is quite unusual to come across such a patient who has not also a considerably heightened systolic blood pressure.

It is evident in the face of these facts, that the reasoned doubts expressed by Sir Archibald Garrod [1] require to be considered.

Reasons for Differentiating Diabetic Retinitis as a Separate Entity.—(1) There is a strong family likeness between diabetic, renal, and arterio-sclerotic retinitis, and there are few individual cases in which it is possible to state dogmatically from an ophthalmoscopic examination alone, that a retinitis which is present is due to diabetes.

At the same time there are features which, whilst they are not pathognomonic, when combined, form a picture which suggests diabetes as the probable cause, and little more than this can be said of renal retinitis, though the difficulty is much less (Fig. 54).

These features are :—

(*a*) The patches of retinal exudate in diabetes tend to have

[1] *Trans. Ophth. Soc. U.K.*, 1920, xl. 6.

sharp-cut edges ; are often solid and soapy or waxy-looking ; are usually distributed in an irregular manner, and sometimes form an irregular ring well wide of the macula (Fig. 54).

(*b*) A star figure is uncommon, and if present it does not

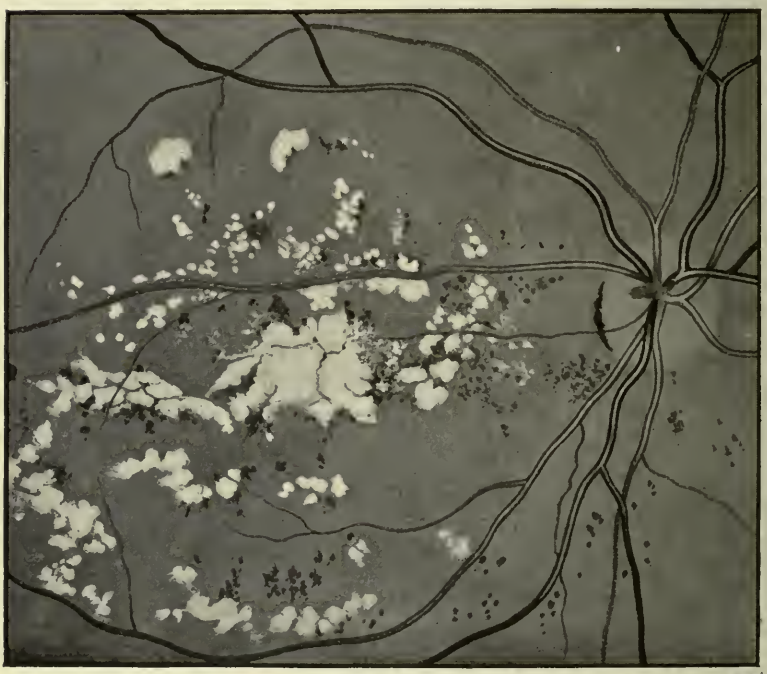


Fig. 54.—From a woman of fifty-seven, the subject of diabetes. Showing the rather solid waxy or soapy-looking exudate distributed roughly in a ring rather wide of the yellow spot ; there is no tendency to the formation of a star figure. The hæmorrhages are small and more or less circular in shape ; flame-shaped hæmorrhages are almost absent.

acquire the degree of symmetry that may be seen in renal cases.

(*c*) The soft-edged cotton-wool patches, so frequent in severe renal cases, do not appear in diabetes ; retinal œdema is never so marked, and thus retinal detachment does not result.

(*d*) Retinal hæmorrhages are generally in the deeper retinal

layers, and therefore are roughly circular in outline instead of being flame-shaped.

(*e*) The circular retinal pigment spots which are not rare in the later stages of renal retinitis are not seen, I think, in diabetes.

(2) As has been said, patients with diabetic retinitis usually have a heightened blood pressure, and albumen in the urine if this be repeatedly examined.

A number of cases have, however, been recorded in which the urine was albumen-free throughout the disease. Nettleship states [1] that he has seen at least twelve such cases. Kako[2] found albumen in twenty-one cases only out of fifty-seven cases of diabetic retinitis. Other such cases are reported by Stephen Mackenzie,[3] James Anderson,[4] Henry Juler,[5] Rockliffe,[6] Hirschberg.[7]

I have seen what I believed to be a typical diabetic retinitis in a man of sixty-three, who had both albumen and sugar in his urine, and whose systolic blood pressure, taken at weekly intervals, never exceeded 155 mm.; it is exceedingly unusual to find either renal or arterio-sclerotic retinitis with a blood pressure so little removed from normal as this. His blood sugar content was so low as 0·05 per cent.

I have seen on several occasions diabetics between the ages of forty and fifty with retinitis, in whom the blood pressure was not at all raised, and the urine was free of albumen.

I think it may be said, on the one hand, that the combination of a normal blood pressure with urine free of albumen is incompatible with a diagnosis of renal or arterio-sclerotic retinitis, and when instead the patient is suffering from diabetes, it would seem hard to deny that the retinitis is indeed due to this latter disease.

[1] *Royal Lond. Ophth. Hosp. Reports*, 1903, xv, 338; *Trans. Ophth. Soc. U.K.*, 1899, ix., 160.
[2] *Klinisch. Monats. f. Augen.*, 1903, xli, 257.
[3] *Royal Lond. Ophth. Hosp. Reports*, 1879, ix., 136.
[4] *Ophth. Review*, 1889, viii., 33.
[5] *Trans. Ophth. Soc.*, 1892, xii., 137.
[6] *Trans. Ophth. Soc.*, 1894, xiv., 130.
[7] *Centralblatt f. prak. Augenheilk.* 1891, xv., 18, 68.

(3) The immediate cause of death was ascertained by Nettleship [1] in twenty-four patients who had diabetic retinitis. Eleven of them died in diabetic coma and four died of gangrene.

(4) The prognosis (*vide infra*) is much less grave than in renal cases.

(5) In its age limit it contrasts markedly with renal retinitis.

(6) It is not infrequently unilateral, and whilst arterio-

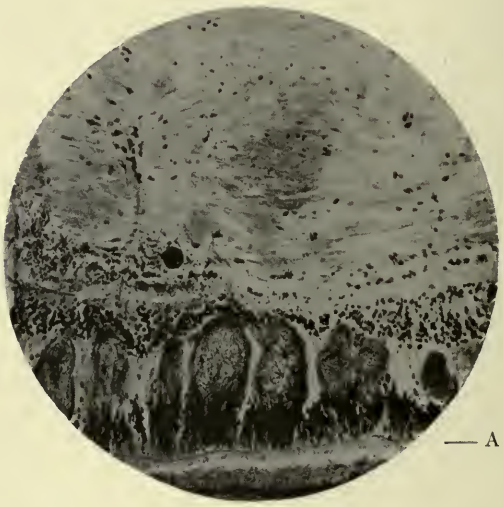


FIG. 55.—A section through the retina showing diabetic retinitis. The fibrinous exudate is almost confined to flask-like cavities in Henle's layer. *A*. Rod and cone layer.

sclerosis is usually present, it has a number of the characters which distinguish it from arterio-sclerotic retinitis.

It is evident that many patients, being diabetics, develop a retinitis, which, but for the disease would not have occurred, and whilst concomitant tissue changes may be wholly or partly responsible for the development of the retinitis, these changes themselves are presumably dependent upon the diabetes.

There seems, then, to be good reason for identifying a special form of retinitis due to diabetes.

It is evident that neither the products of perverted meta-

[1] *Royal Lond. Ophth. Hosp. Reports*, 1906, xvi., 14.

bolism, di-acetic acid and acetone, nor hyperglycæmia, are responsible for the development of the fundus disease, for young subjects in whom these manifestations are most advanced are free from retinitis.

Incidence.—Age.—Retinitis affects older patients only. Nettleship states [1] that of fifty-nine patients of his own and twenty-three published cases, eighty-two in all, the youngest was thirty-five. Of sixty-two patients of my own [2] the youngest was thirty-nine.

It may be said for practical purposes that diabetic retinitis does not occur under the age of thirty-five.

It is not easy to form an estimate as to the frequency of the condition, for in a general hospital the majority of diabetic patients who are admitted to the wards are the young, in whom retinitis does not occur, whereas those who attend an ophthalmic hospital come only because their sight is defective, and consequently include many cases of retinitis.

Of fifty-one patients of all ages admitted to St. Bartholomew's Hospital five only had retinitis. Kako found fifty-seven cases amongst 192 cases of diabetic eye affection.

Prognosis.—The prognosis is not nearly so grave as in renal retinitis, nor so grave as in artero-sclerotic retinitis. Of forty-eight patients kept under observation by Nettleship,[3] thirty-eight were known to have died, and ten were known to be alive at periods varying from two to ten years after the discovery of the retinitis. Of the thirty-eight, nineteen died within two years of the discovery of the retinitis; the remaining nineteen died within a period varying from two to eight years. Thus, of forty-eight patients, 60 per cent. lived for longer than two years after retinitis was found to be present.

Hæmorrhages.—Apart from the presence of other changes, diabetics are especially liable to intra-ocular hæmorrhages.

These may occur amongst the layers of the retina, and if confined to this structure are readily visible ophthalmoscopi-

[1] *Royal Lond. Ophth. Hosp. Reports*, 1903, xv., 339.
[2] *Trans. Ophth. Soc. U.K.*, 1920, xl., 16.
[3] *Royal Lond. Ophth. Hosp. Reports*, 1906, xvi., 11.

cally, and will have characteristic features, according as the nerve fibre layer or the deeper layers are concerned. Sometimes all the retinal layers are widely infiltrated, at other times hæmorrhages of the subhyaloid type occur, or again, bleeding may take place into the vitreous body and may

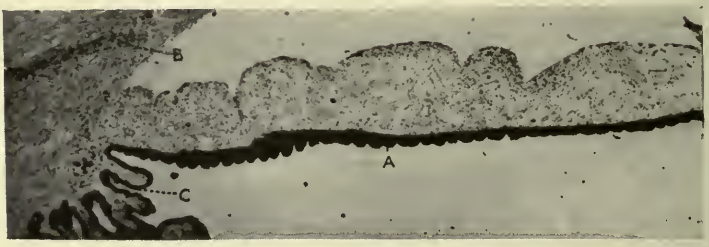


Fig. 56.

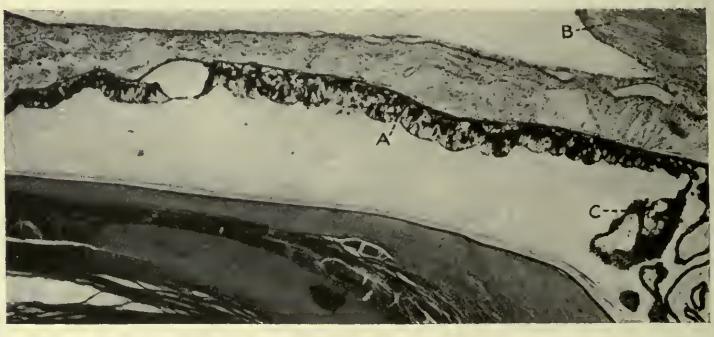


Fig. 57.

To show the condition of the pigment epithelium on the posterior surface of the iris in a case of diabetes, and in a normal eye. Fig. 56 shows the normal condition of the epithelium, Fig. 57 the condition of this layer in diabetes. *A*. Pigment epithelium. *B*. Cornea. *C*. Ciliary body.

be seen as a smoky cloud, or may entirely obscure the view of the fundus. Occasionally massive craggy white areas are to be seen which are clothed by the retina, the retina itself being free of hæmorrhages, the condition is not by any means a retinitis; it seems likely that these areas are due to hæmorrhages of the choroid, but of this I know of no proof or supporting evidence.

As showing the liability of diabetics to retinal hæmorrhages,

Schweigger [1] found that of 45,000 patients, 450 had retinal hæmorrhages with or without retinitis ; of these rather more than one-fifth were diabetics, and of them, those with hæmorrhages only were three times as common as those with retinitis.

Iritis.

Having regard to the almost constant presence of marked histological changes in the epithelium on the posterior surface of the iris in diabetic eyes (Fig. 57), it is remarkable that clinical evidence of iritis is so infrequent.

When it occurs a gelatinous exudate may form in the anterior chamber somewhat like that seen in a primary gonorrhœal iritis, but lacking the yellow tinge; it rapidly and completely disappears under treatment.

The changes in the pigment epithelium have been described by a number of observers.

Kako describes a great enlargement of the pigment epithelial cells with reduction in the pigment. A considerable thickening of the iris results with exaggeration of its normal folds. The changes stop short of the pupillary margin of the iris, but extend for a short distance into the ciliary body. He states that of twenty-seven reported examinations, these changes were present in twenty-five. Hoffmann [2] states that the epithelium is proliferated, is deficient in pigment, and is laden with glycogen. Becker and Kamocki found that the process extended to the retina.

Lipæmia Retinalis.

This term is applied to an exceedingly characteristic ophthalmoscopic picture which occurs in some cases of lipæmia, and was first described by Heyl.[3]

Pathological lipæmia occurs in a number of diseases, but only in diabetes does it attain a sufficiently high degree to manifest itself to ophthalmoscopic examination.

Heine believes that the fat content of the blood must reach

[1] *Inaug. Dissert.*, Berlin, 1897.
[2] *Archives of Ophth.*, 1914, xlii., 41.
[3] *Trans. Amer. Ophth. Soc.*, 1880, iii., 54.

5 per cent before it is seen. Thorner reports a case in which the blood contained 26 per cent. of fat.

In the early days of the war I examined a series of 119 men suffering from "trench nephritis" as to their eye condition.[1] Of these, four had well-marked lipæmia or lecithinæmia, but in none of them was it sufficiently marked to give rise to the ophthalmoscopic picture of "lipæmia retinalis."

The number of recorded cases is few, but if all young diabetics who are approaching coma be examined, it will not be long before the searcher is rewarded.

No case has been recorded in an old patient; the oldest I have been able to find is reported by Darling [2] in a man of forty-eight. My own patients were aged twenty-three, twenty-five and twenty-five.[3]

I have watched the gradual evolution of lipæmia retinalis in the course of six weeks, in a man who was known to have lipæmia, but who did not at first show any signs in the retina.

The first indication was a slightly milky or hazy appearance of the retinal vessels, their colour otherwise remaining normal; slowly this milkiness became more pronounced and the colour became more cherry red. The arteries and veins approximated each other in colour until ultimately the fully developed picture occurred shortly before death. In the fully developed condition both arteries and veins for the whole of their extent have an appearance as if filled with milk; but short of this, in some cases the vessels on the disc have a cherry red or salmon colour, merging into cream shortly after leaving its edge. Both sets of vessels look flat and ribbon-like; they appear to lose their cylindrical contour, thus simulating the normal appearance of the choroidal vessels. The veins are often engorged, sometimes markedly so. The disc edges remain sharp and clear, neither hæmorrhages nor exudates occur, and the vision is unaffected.

It will be seen that the changes are entirely limited to the appearance of the retinal vessels. The condition is most

[1] *Lancet*, 1915, ii., 1348.
[2] *Archives of Ophth.*, 1912, xli., 355.
[3] *Lancet*, 1915, i., 367; *Trans. Ophth. Soc. U.K.*, 1920, xl., 21.

striking; is pathognomonic, and cannot be confused with any other ophthalmoscopic picture.

Death usually follows shortly upon the discovery of the condition, but Hale White [1] and Marx have each reported a case in which recovery ensued, and the eye fundus again became normal in appearance. I have seen a case in which the partially developed appearances disappeared completely under treatment in the course of a week.

Sections of the retina and choroid of my last case showed the vessels filled with blood the plasma of which was well stained by Sudan III., but only in a few places was any substance stained by osmic acid.

Alterations of Refraction.

A number of observers have reported rapid alterations of the refraction of the eye, due, it is presumed, to alteration in the refractive power of the lens, and varying with the sugar output. In most cases there has been an alteration towards myopia with increase of sugar output, and a rapid return towards the normal with a decreased sugar output. The alterations have been as much as seven dioptres. This is clearly a possibility to have in mind in connection with the development of amblyopia in diabetics.

Grimsdale [2] reported the case of a man who rapidly developed two dioptres of myopia with return to the normal in ten days. Other cases are reported by Risely [3]; Gould [4] collected twenty-seven cases, in fourteen of which there was an alteration towards myopia, and Lundsgaard [5] records a case in which there was an alteration of seven dipotres.

Difficulty with near vision is a frequent complaint of diabetics; it is a result of defective power of accommodation due to the general debility resulting from the disease.

Cataract.

Cataract occurs in two chief forms in diabetes; the one forming rapidly in young subjects, the other a much more

[1] *Lancet*, 1903, ii., 1007.
[2] *Trans. Ophth. Soc.*, 1899, xix., 267.
[3] *Trans. Amer. Oph. Soc.*, 1897, viii., 121.
[4] *Med. Record*, 1907, lxxi., 633.
[5] *Klin. Monats. f. Aug.*, 1910, xlviii., 2, 38.

slowly developing form in old patients. The term "diabetic cataract" is best restricted to the former of these.

The characteristics of this variety are, that it develops rapidly, usually commences in the posterior layers of the lens, is of a homogeneous texture, is bilateral, and occurs only when the disease is well advanced. In many cases the condition of the patient is such as to make operation for the condition inadvisable, but in some cases removal is desirable, and James [1] has shown what good results are usually obtained.

Of my cases of diabetes under the age of forty, twenty-nine in number, two only had cataract. In diabetics over the age of fifty opacities are much more common; it has to be remembered, however, that at and beyond this age senile lens opacities are of very frequent occurrence, and are increasingly common as age advances, until at the age of sixty, about 90 per cent. of all subjects have some degree of opacity in the lens.

There is nothing in the appearance of the lens opacity in these patients to distinguish it from an ordinary senile cataract, though probably it is true, that the frequency of cataract in older diabetics is greater than in other patients of the same age without diabetes. Kako found eighty-four cases amongst 194 patients suffering from diabetic eye affections; he expressly states, however, that the number includes senile cataracts occurring in diabetic patients.

This form of cataract often calls for removal, and whilst the healing is often less smooth and less free from complications than in uncomplicated senile cases, the majority do quite well. Sir Archibald Garrod recommends that a preliminary dietetic *régime* on Graham's lines should always precede operation for at least two weeks. Burdon Cooper [2] has shown that in senile cataract the lens albumen is broken down to tyrosin, and he suggests that in diabetic cases cholesterin may be formed and be responsible for the opacity.

Retro-bulbar Neuritis.—Without objective disease in any part of the eye, a certain number of diabetics complain of defective vision. Some of these are no more than a failure of the ciliary

[1] *Trans. Ophth. Soc. U.K.*, 1920, xl., 40.
[2] *Trans. Ophth. Soc. U.K.*, 1920, xl., 45.

muscle owing to general debility, producing difficulty in reading for the emmetrope, and general amblyopia for the hypermetrope. Some, however, are due to a retro-bulbar neuritis. It occurs in middle-aged patients, and the onset may be rather sudden.

Of sixty-one diabetic patients of all ages this condition was present in six. The average age was thirty-six the oldest being fifty-three, in none was there any discoverable disease of the eye to account for the loss of sight. Leber [1] has seen fourteen cases amongst fifty cases of diabetes. I have had a man brought to hospital because he could only dimly see people walking. I sent a man home from France for this condition and saw him again two years later; he was an advanced diabetic, his discs showed a mild degree of atrophy, and in addition to an absolute central scotoma he had no appreciation of colour, and had a large nasal defect in his visual fields.

A patient who had been in hospital for a number of weeks for diabetes awoke one morning to find everything, both near and distant, was misty; he was unable to read, whereas the night before he was reading a book without trouble; he was both acetone free and sugar-free at the time; he completely recovered in the course of ten days.

There can be no doubt that diabetics are more vulnerable to the toxic effects of smoking than are healthy patients, and it is difficult at times to determine which of the two, the diabetes or the tobacco, is the real factor in the production of the neuritis.

Thus Kako [2] states that of sixteen cases, in two only could alcohol and tobacco be excluded as a cause. On the other hand, Reber [3] reports a case which persisted for two years, the woman being a non-smoker. I have seen it in a woman who denied smoking, and have watched it develop in a man whilst he was in hospital, where smoking was not permitted.

If the neuritis is prolonged some degree of permanent atrophy results, as was shown histologically by Lawford and Edmunds,[4]

[1] *Bericht. der. ophth. Gesells.*, Heidelberg, 1896, xxv., 104.
[2] *Klinische Monats. f. Augen.*, 1903, xli., 253.
[3] *Ophth. Record*, 1910, xix., 124.
[4] *Trans. Ophth. Soc. U.K.*, 1883, iii., 160.

and Schmidt Rimpler.[1] Its development does not appear to indicate an increase in gravity of the prognosis.

Ocular Tension.—It has been pointed out by Heine,[2] that in some cases of diabetic coma there is a remarkable diminution in the intra-ocular tension which is readily appreciable to the touch; it is not caused by a corresponding fall in the blood pressure.

EXOPHTHALMIC GOITRE.

The ocular symptoms of this disease are both striking and important, and few cases occur in which some of them are not present; they are, however, entirely limited to the exterior of the eye, and its appendages; retinal, pupillary, or other intra-ocular changes do not occur.

Von Graefe's Sign.—This sign consists in the failure of the upper lid to follow the eyeball on looking downwards. Von Graefe himself looked upon it as one of the early signs of the disease, others have looked upon it as of late occurrence.

Hill Griffith [3] has described a lagging behind of the lower lid on looking upwards.

The frequency of occurrence of von Graefe's sign is given by Dock as 50 per cent. of cases.[4] Mannheim [5] found it in eighteen out of forty-one cases, and Murray in thirty-six out of ninety-one cases. Sharkey [6] has shown that it is not limited to cases of Graves' disease, but that of 613 cases of all kinds of diseases, excluding Graves', it was present in twelve cases, and that many people can produce it voluntarily.

It is quite independent of protrusion of the eye, for it may be present in the entire absence of proptosis; it may disappear, the exophthalmos remaining; and von Graefe states he once saw it disappear after an injection of morphia, the exophthalmos being unchanged.

Dalrymple's Sign.—This sign consists in a retraction of the

[1] *Bericht der ophth. Gesellsch.*, Heidelberg, 1896, xxv., 99.
[2] *Klin. Monats. f. Augen.*, 1906, xliv., ii., 451.
[3] *Trans. Ophth. Soc. U.K.*, 1886, vi., 61.
[4] Osler's "System of Med.," 1915, iv., 863.
[5] "Der Morbus Gravesii," Berlin, 1894, 75.
[6] *Lancet*, 1890, ii., 877.

upper lid, producing a staring, frightened appearance, which is very characteristic.

According to Sattler this sign was first pointed out by Dalrymple, and afterwards carefully studied by Stellwag whose name is sometimes attached to it.

It is a very frequent sign; Hill Griffith found it in nineteen out of twenty-two cases in which it was looked for. It is said to come on early (Dock).

Stellwag's Sign.—By this is meant marked infrequency and incompleteness of the blinking reflex, a condition which predisposes to the development of corneal ulceration and conjunctivitis; it may be associated with a partly dulled corneal sensation.

By some, Stellwag's name is attached to a combination of the above with what has here been described as Dalrymple's sign.

Moebius' Sign.—This consists in a difficulty of convergence of the eyes on near objects, and is quite independent of muscular paralysis; it is said to be independent of the mechanical effects of the proptosis.

It is not a sign of great importance for severe proptosis from any cause will produce some difficulty with convergence.

Exophthalmos.—This constitutes one of the three classical signs of the disease, and according to Dock it occurs in about 70 per cent. of cases. Wilbrand and Saenger [1] found it in twenty-seven out of thirty-nine cases.

The eye is pushed directly forwards, a point which helps to distinguish the condition from the proptosis caused by some intra-orbital growths. As a rule both eyes are affected, but it is common to find one more prominent than the other, and in the early stage one eye may commence to be prominent before any noticeable change is present on the other side. Of thirty-two cases Hill Griffith found unilateral proptosis in 22 per cent., and Wilbrand and Saenger state that four of their twenty-seven cases were unilateral.

The prominence may vary in degree from time to time, and it is stated that its onset may be rapid; thus, Falta [2] says

[1] "Die Neurologie des Auges.," 1900, i., 50.
[2] "Die Kikrankungen der Blutdrüssen," Berlin, 1913, 50.

exophthalmos may even come on in one night or in a few days, and Dock [1] says it "may come on in a few days or *even minutes*, but usually does so slowly." There is no doubt that the proptosis is usually of comparatively slow development, and a sudden development of it is excessively rare if ever it occurs.

Great variations in the degree of the proptosis occur, the eyes may be pushed so far forwards that the lids are no longer able to close over the corneæ, and indeed, the globe may be dislocated in front of the lids.

Even when the exophthalmos is not very severe, conjunctivitis and corneal ulcers are common on account of the unusual exposure, and are probably further predisposed to by the reduced frequency of blinking, but in cases where the lids are unable to meet, severe corneal ulceration is greatly to be feared, and is inevitable where dislocation forward takes place, for in this case the cornea is no longer moistened by the tears; it becomes dry and parchment-like, and presently sloughs leading to destruction of the eye.

Many cases are on record of the complete loss of both eyes by this means: Jessop [2] reports three such, and tabulates twenty-five cases from the literature in most of which there was complete bilateral loss of sight from corneal lesions. Griffith [3] reports the case of a woman in whom both eyes were destroyed in this way, and in whom after the removal of both eyes, the lids were still unable to come together over the orbital contents.

The proptosis may remain in greater or less degree for years after all other evidence of the disease has disappeared. Goulden has operated upon a woman for cataract at the age of sixty-eight in whom marked proptosis was present, the residue of an attack of Graves' disease forty-nine years previously.[4]

Different explanations of the immediate cause of the proptosis have been advanced. Thus it has been attributed to vascular engorgement, to contraction of unstriped muscle tissue in the orbit, and to the deposition of fat in the orbit.

It is evident if it can be substantiated that the proptosis

[1] Osler's "System," 1915, iv., 862.
[2] *Trans. Ophth. Soc. U.K.*, 1896, xvi., 187.
[3] *Ophth. Review*, 1898, xvii., 198.
[4] Foster Moore, *Lancet*, 1920, 701.

disappears after death, or that it may come on in a night (Falta), or in " even minutes " (Dock), that in such a case it is not due to an increase of the orbital fat.

Opportunities of really testing such statements are necessarily few, and it is clear that the accounts of patients on such a point are of little or no value. The sudden development of Dalrymple's sign may simulate proptosis, or may call the attention to a proptosis which previously had gone unobserved. I have never found reason to believe in an individual case, that proptosis had developed suddenly, nor have I been able to procure such evidence from my colleagues.

Opportunities for post-mortem examinations are rare in a general hospital. West [1] states that during fourteen years, only three patients with exophthalmic goitre died in St. Bartholomew's Hospital.

I have once only had an opportunity of making such an examination, and in this woman the proptosis after death was only so much less than during life, as might be expected from the draining away of blood from the orbit, the orbit was full of fat, and no other abnormality was present.[2]

I have in addition once explored an orbit during life, in which proptosis was so extreme, that the lids could not, even under general anæsthesia, be brought together over the cornea; there was nothing to be felt but soft unresisting fat, which together with the ocular muscles (to be referred to later) seemed to be markedly œdematous.[3]

Bristowe [4] reports four autopsies in patients dead of this disease. In three of them he states: " a distinctly increased quantity of yellow fat," " there was much fat in the orbits," " both orbits contained a great excess of fat," and in all three no other abnormality was present. It is worthy, too, of note, that whilst the orbits were full of fat, three of the bodies are expressly stated as being emaciated. In the fourth case it is simply stated that the ocular muscles were pale.

[1] *Trans. Ophth. Soc. U.K.*, 1886, vi., 76.
[2] Foster Moore, *Lancet*, 1920, 701.
[3] Foster Moore, *Pro. Roy. Soc. Med.*, Oph. and Neurol. Sect., March, 1921.
[4] *Trans. Ophth. Soc. U.K.*, 1886, vi., 42; " Diseases of the Nervous System," 1888, 141.

In a case of Higgens, reported by Goodhart,[1] the orbits showed nothing abnormal; it is, of course, difficult to identify what is an excess of fat in a cavity which normally is full of it.

Silcock,[2] in an autopsy to be referred to later, in which all the orbital contents were examined histologically, says: "no trace of Muller's musculus orbitalis was visible."

It seems unlikely, *à priori*, that this single manifestation of so sharply defined a disease, should at different times have three entirely and widely different immediate causes for its production. It is evident from post-mortem examination and operative experience, that at any rate the usual cause of the prominence of the eyes is an increase of the fat in the orbit, and this, even though the patient is greatly emaciated.

This view receives additional support from the usual slowness of development of the proptosis and from its long persistence—forty-nine years (Goulden)—after the disease has ceased; it may also be that œdema of the orbital tissues, which seemed undoubted in the case previously referred to, and which is probably responsible for the bogginess of the tissues of the lids when this occurs, is an additional factor.

As has been stated, the condition has also been attributed in certain cases to engorgement of the orbit with blood, and to the contraction of unstriped muscle tissue in the orbit under sympathetic control. So far as I can find out, the only support for such suggestions is, first, the statement that the proptosis disappears after death, secondly that it may develop in so short a time that the possibility of the deposition of fat can be ruled out, "as during the night" or "even in a few minutes," and thirdly that in some cases recession of the eye is reported to have followed division or resection of the sympathetic nerve in the neck.

So far as the first of these statements is concerned, what post-mortem evidence I have been able to find is in direct opposition to it. Of the second statement I can only say that I have not been able to gather from my own experience or from that of my colleagues any satisfactory evidence of a sudden or very

[1] *Trans. Path. Soc.*, 1874, xxv., 240.
[2] *Trans. Ophth. Soc. U.K.*, 1886, vi., 103.

rapid onset, and I suggest that in those instances in which it has seemed to occur, it may have been due to the sudden development of Dalrymple's sign simulating proptosis, or unmasking an early proptosis which up to then had been overlooked. In this connection it is of some interest to observe, that in the contrary case it is not rare for patients who have developed a partial ptosis from third nerve involvement, to come complaining that the eye is getting smaller or is sinking into the head.

In addition I know of no anatomical evidence of the existence of such unstriped muscle tissue in the orbit in man as could produce the effect, and Silcock's histological examination already referred to, failed to reveal any trace of Müller's muscle.

With regard to the effects of division or resection of the sympathetic nerve in the neck, there is no unanimity of opinion as to its effect on the exophthalmos. Thus Jaboulay [1] says of eight cases in which the sympathetic was divided, that the exophthalmos was favourably influenced in all cases after the first day, a view which receives some support from Gayet.[2]

Balacescu,[3] on the other hand, finds little effect on the exophthalmos produced by section of the nerve, a view which coincides with that of Pean.[4]

If the exophthalmos is, indeed, due to contraction of unstriped muscle tissue under the control of the sympathetic nerve, it would be expected that the effect of division would be immediate, and of such a degree that there could be no room for views so diametrically opposed as to its effect.

I believe it may be said that the immediate cause of the exophthalmos of Grave's disease is an increase of the orbital fat, perhaps combined with œdema of the tissues, and that there is at present no satisfactory evidence of any other cause of it.

Defective Ocular Movements.—Paralysis of some of the external ocular muscles is at times seen, but ophthalmoplegia interna does not occur.

The external rectus is most often affected, but at times the

[1] *Chir. du Grand Sympath. et du Corps Thyroide*, 1900, 79.
[2] *Lyon Médical*, 1896, lxxxii., 423.
[3] *Archiv. f. Klinische. Chir.*, 1902, lxvii., 59.
[4] *Bull. Acad. de Med.*, 1897, xxxviii., 132.

internal rectus is involved, and it is stated that occasionally all the external muscles may be paralysed or defective in action ; the effect may be transient or intermittent.

Cases are reported by Lang and Pringle,[1] West,[2] Ballet,[3] Bristowe,[4] Warner,[5] Maude,[6] Voss,[7] and others, in some of which other cranial nerves have also been involved.

It is probable that the defective movements are due to changes in the muscles, rather than in their nerves of supply, a view which is supported by the distribution, and by the fact that definite changes have been found in the muscles.

In a case of my own, the recti muscles during life, instead of being thin, flat bands, were fusiform bellies, almost as thick as the top of one's little finger, due, it seemed to me at the time, to œdematous swelling, but perhaps due to fatty infiltration (*vide infra*).

In a case of Bristowe's [8] in which ophthalmoplegia externa had occurred and which came to autopsy, the muscles are described as being pale.

A most careful examination of a case was made by Silcock,[9] all the orbital tissues being examined histologically. He says : "There was nothing abnormal in the orbits except a most noticeable yellowish, patchy discoloration of the recti and oblique muscles, which a microscopic examination proved to be due to interfascicular fatty infiltration, the muscle fibres themselves, though somewhat pale, showing no trace of fatty degeneration. The levatores palpebrarum markedly contrasted with the other extrinsic ocular muscles inasmuch as they were normal in colour, or perhaps merely a shade paler than normal."

The vessels and nerves were all examined histologically, and showed no abnormality.

[1] *Trans. Ophth. Soc. U.K.*, 1886, vi., 105.
[2] *Trans. Ophth. Soc. U.K.*, 1886, vi., 79.
[3] *Recueil d'Ophthal.*, 1888, 321.
[4] *Brain*, 1886, viii., 313.
[5] *Med. Times and Gaz*, 1882, ii., 541.
[6] *St. Bartholomew's Hosp. Reports*, 1891, xxvii., 133.
[7] *Deutsche med. Wochenschr.*, 1903, xxix., 590.
[8] "Diseases of the Nervous System," 1888, 141.
[9] *Trans. Ophth. Soc. U.K.*, 1886, vi., 43.

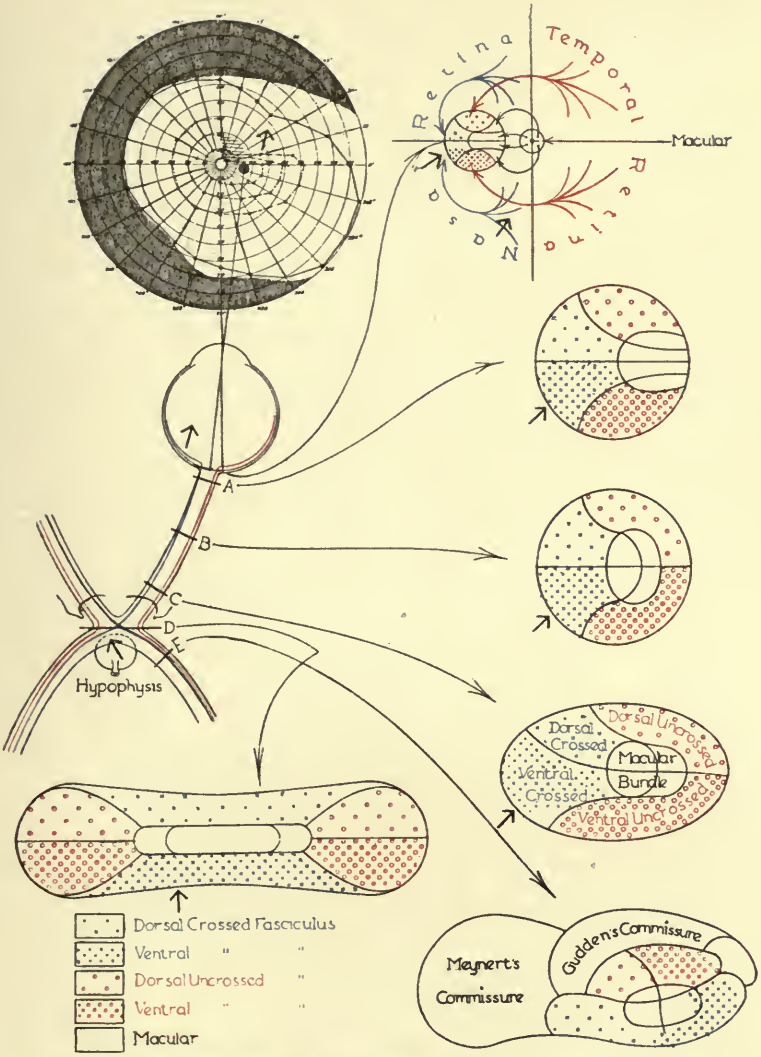


FIG. 59.—Diagram based on Henschen's conception of the disposition in the optic nerve of the several fasciculi. There is indicated an hypothetical involvement of the ventral crossed fasciculi from the right eye, which has produced Stage I. (see Fig. 60) of a right temporal defect (*cf.* included perimetric field). The path of the fibres between the point of pressure at the chiasm and the retina is indicated by the short arrows. (Harvey Cushing and Clifford B. Walker.)

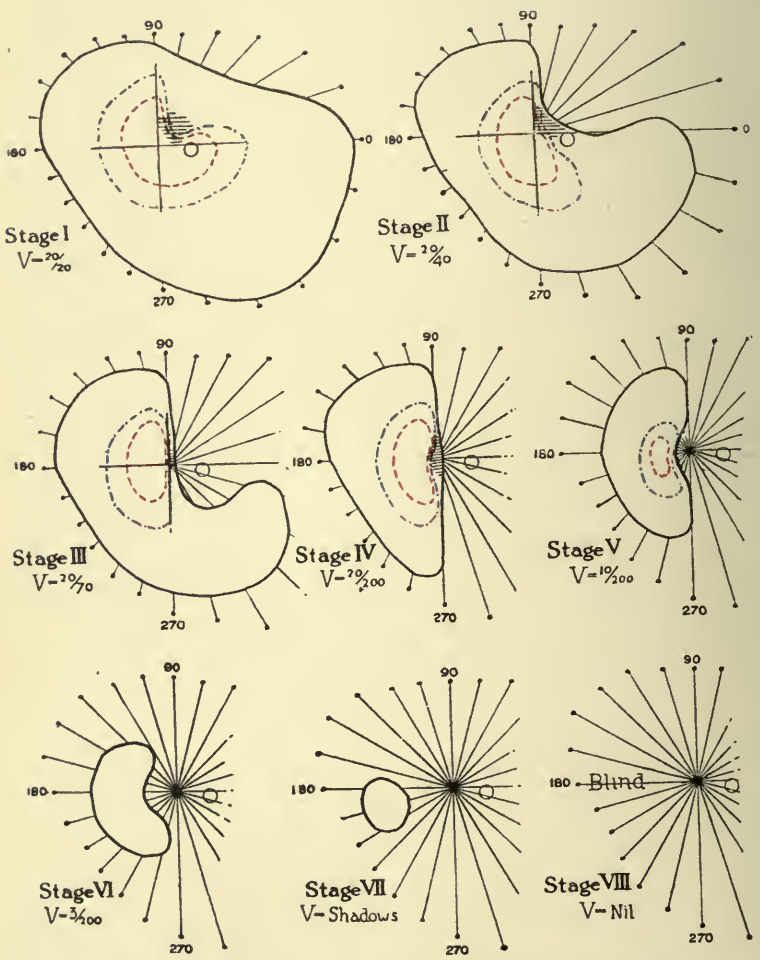


FIG. 60.—Showing the eight stages of a progressing right temporal field defect in pituitary disease. (Harvey Cushing and Clifford B. Walker.)

It seems probable, that when deficient movement of the eyes occurs in Graves' disease, it is due to impairment of function of the muscles as a result of their infiltration by fat or by œdema, or perhaps by both, and that marked exophthalmos, when present, will introduce a mechanical factor which will contribute towards the same effect.

I have once seen a typical retro-bulbar neuritis associated with Graves' disease which recovered completely in the course of about three months, but whether this was a part of the disease or an accidental complication of it I am unable to say.

PITUITARY DISEASES.

Owing to the proximity of the pituitary body to the optic pathways, ocular lesions constitute some of the most important complications of pituitary disease, and almost all of these complications are dependent upon the direct pressure of the enlarged gland.

For much of our recent and improved knowledge, and consequent earlier recognition of the diseases of the pituitary, we are dependent upon the skill and labour of Harvey Cushing and C. B. Walker, from whose work much of what follows is taken.

The chief changes to be considered are defects of the visual fields and objective signs in the eye grounds.

There are three separable factors in pituitary disorders [1] :—

(1) Neighbourhood signs and symptoms shown by evidence of pressure on adjoining structures, chiasm, cranial nerves, uncinate gyrus, crura cerebri, and sella turcica.

(2) General pressure symptoms, in case the growth becomes large enough to cause considerable cerebral deformation or to obstruct the cerebro-spinal fluid circulation by blocking the foramen of Munro.

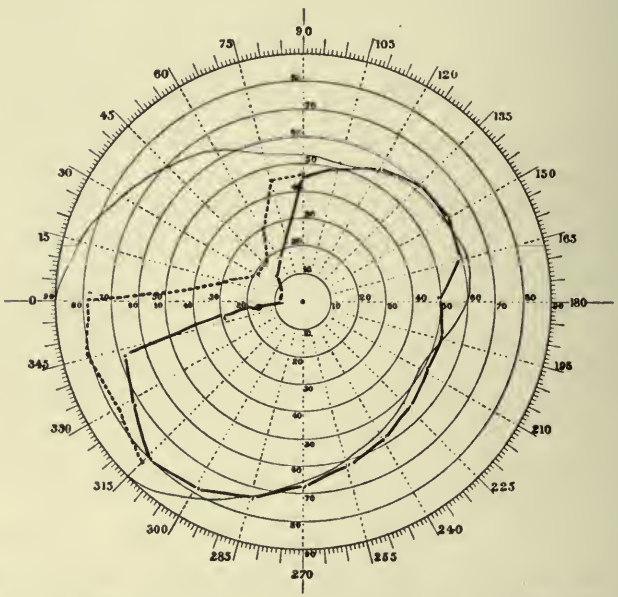
(3) Constitutional or glandular symptoms, either in the *rôle* of over- or under-hypophysical activity.

With the last of these we shall not find ourselves concerned.

[1] Cushing and Walker, *Archiv. of Ophth.*, 1916, xlv., 407, and 1918, xlvii., 119; *Brain*, 1914, xxxvii., 341.

Defects in the Fields of Vision.—These have been studied with minute care in all their phases of deterioration and subsequent recovery by Walker, by whom, for purposes of description, they are divided into four groups :—

(1) Bitemporal hemianopia.
(2) Homonymous hemianopia.
(3) Blindness in one or both eyes.
(4) Irregular defects.



FIGS. 61 and 62.—To show the progress of the loss of the upper temporal fields of vision in a lad of seventeen suffering from a pituitary tumour. The dotted line shows the field taken forty-two days before the continuous line.

With regard to these defects it is strongly emphasised that the process rarely advances with equal steps in the two eyes, and consequently it is unusual to find bilaterally symmetrical defects ; and, further, it is important to realise that there are probably recessions and advances from time to time, though the general tendency is towards advance.

Of 271 cases of pituitary lesions 148 showed some abnormality of the visual fields. Of these forty-seven were bitemporal

defects, twenty-two were homonymous, and seventy-nine had one or both eyes blind, so it could not be stated what form of defect was present.

Amongst seventy-nine cases reported by de Lapersonne [1] bitemporal defects were present in 32 per cent, whilst amongst Uhthoff's cases,[2] of 119 without signs of acromegaly or other trophic disturbance, 28 per cent. had bitemporal defects,

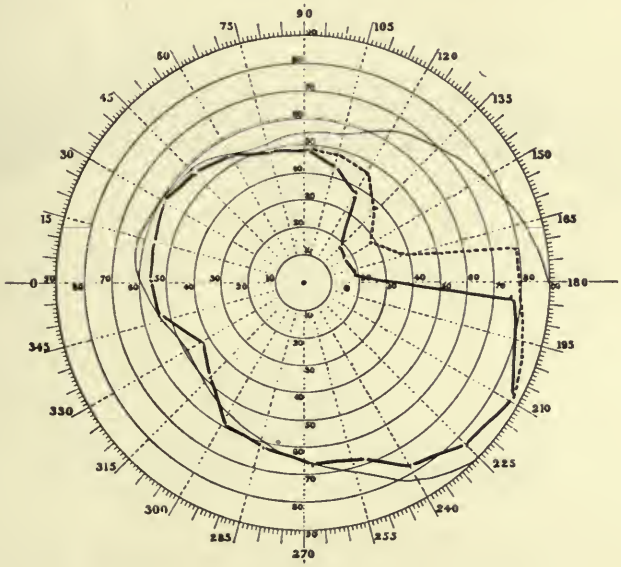


FIG. 62

whilst of 207 cases with acromegaly, etc., 42 per cent. had such defects in the fields of vision.

The most typical form of field is a bitemporal hemianopia ; but, contrary to what might be expected, a hemianopia of homonymous type is by no means rare. According to Uhthoff it is about ten times as uncommon as a bitemporal defect, but Cushing and Walker's figures indicate that it is only about twice as infrequent.

Besides these defects which can be classified, there is left a large group of cases in which, owing to the advanced condition

[1] Quoted by Werner, *Trans. Ophth. Soc. U.K.*, 1912, xxxii., 295.
[2] Bowman Lecture, *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., xcii.

of the visual loss in one or both eyes at the time they first come under observation, it is not possible to say what was originally the condition.

It is suggested by de Schweinitz and Carpenter [1] that probably many individual variations in decussation occur, from perhaps entire absence of crossing to total decussation; any such variations would influence the type of field defect in the cases under consideration.

In a majority of cases, whether intra- or supra-sellar, the first

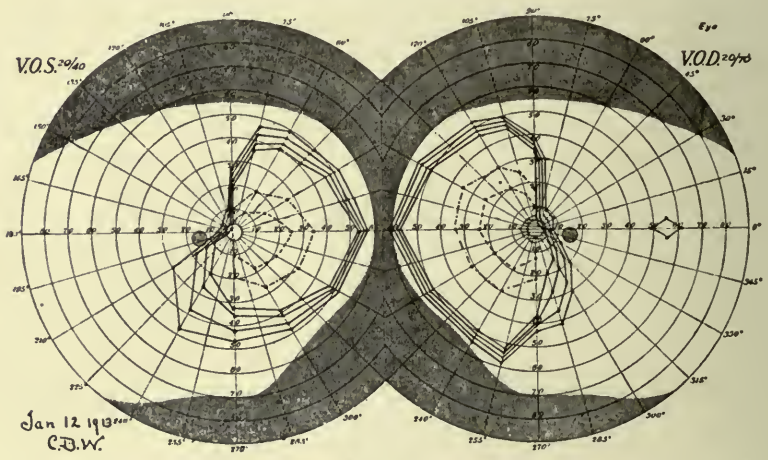


FIG. 63.

FIGS. 63 and 64 are charts of the visual fields of a man aged thirty-two suffering from an hypophysial struma with optic atrophy. He had had occasional diplopia and trouble with his eyes for six or seven years. Fig. 63 shows the fields before operation. Both eyes are just short of Stage IV. (see Fig. 60). Note the island of vision in the right temporal field.

perimetric indication of the process is shown by a slant in the boundary of the upper temporal form field, and a corresponding quadrantal defect in the colour periphery (Fig. 60, Stage I.).

In all cases the loss of colour perception is in advance of that for form. The defect commences in the upper temporal field, and progresses more rapidly in the centre than towards the periphery, so that a gourd-shaped field is produced (Fig. 60, Stage III.), and it comes about as a result of the further advance of this same process, that an island of field may

[1] *Jour. Amer. Med. Assoc.*, 1905, xliv., 81.

become cut off in the lower temporal part, whilst for the rest the process results in a sharp-cut temporal hemianopia, the nasal field remaining. This temporal island of field is very constantly about 50 degrees from the fixation point on or below the horizontal meridian (Figs. 63 and 64).

The nasal field next begins to shrink approximately concentrically, so that ultimately only a small functioning patch remains in the lower nasal quadrant (Fig. 60, Stage VII.).

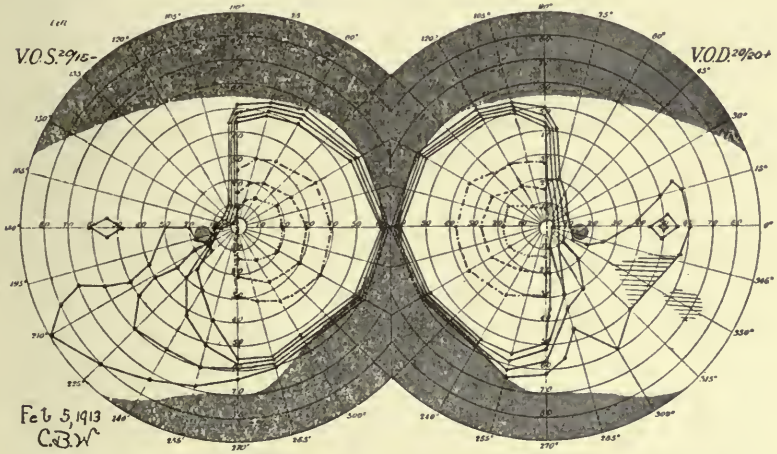


Fig. 64.—From the same patient as Fig. 63, taken twenty-four days later and eighteen days after operation. Shows increase of the visual fields with recession towards Stage III. (Fig. 60) and engulfing of the island in the right temporal field by the 16 sq. cm. disc. Notice the development of a symmetrical island in the left temporal field. (Cushing and Walker.)

The gradual evolution of these half field defects contrasts sharply with the common cortical hemianopias which are usually of sudden onset and complete from the first.

In cases of supra-sellar tumours in the interpeduncular space, contrary to what might be expected, the field defects do not appear first in the lower temporal field, but frequently follow the typical stages.

Physiological Block.—Great importance is attached to the evidence supplied by these cases as showing that loss of visual field and even marked pallor of the optic disc is not at first due to organic change in the nerve, but is produced by what Cushing

calls a physiological block, and consequently the prospect of recovery of function if pressure can be relieved is much improved.

Cushing states that vision has been restored to blind eyes even when the pupil reflex had been lost, and that in several cases where the ophthalmoscope had shown advanced atrophy and the perimeter advanced defect, only a scattered degeneration was found histologically.

Forti [1] makes the interesting observation that in pregnant women in perfect health there is a restriction of the temporal visual fields; it is presumably due to hypertrophy of the gland during pregnancy, and is afterwards recovered from.

The occurrence of scotomata in the visual field is not rare. They were first accurately investigated by de Schweinitz and Holloway [2] who showed that they are usually either macular or paramacular, probably because the corresponding fibres are more vulnerable than those from the peripheral retina, and it is perhaps for this same reason that they tend to persist after the rest of the field of vision is restored.

Mode of Restoration of the Visual Fields.—When relief of pressure has been afforded by operative measures, the recession of the defects takes place in a sequence the reverse of that characterising the stage of the advance, but as already stated, scotomata, if present, tend to persist (Figs. 63 and 64).

The restoration of the visual field peripheries is possible even when the process has advanced beyond the stage of half vision, and some sight may be regained even after blindness has occurred, provided that it has not been of too long duration.

The recovery of the affected parts of the field may be very rapid after operation, and nearly all cases improve if operated on before the stage of complete loss of temporal field, the nasal fields being intact.

Fisher [3] suggests that the distortion of the fields of vision is the result of traction upon the nerve and chiasm rather than of direct pressure upon these parts, and that the vulnerability

[1] *Archiv. Di Ottalmol.*, xvii., 8.
[2] *Jour. Amer. Med. Assoc.*, 1912, lix., 1041.
[3] *Proceed. Roy. Soc. Med.*, London Sect. Neurol. & Ophth., 1912-13, vi., 3, lxvii.

of the macular fibres is associated with their highly specialised function.

Walker and Cushing believe that pressure and traction go hand in hand, and from their post-mortem examinations they consider that the tracts suffer more than the nerves or chiasm, for they may be thinned out into mere ribbons even when the chiasma shows little deformity; their post-mortem examinations also demonstrate that the chiasm may undergo considerable distortion without producing demonstrable alterations in the visual fields, for in about 20 per cent. of cases actually showing neighbourhood signs there was no perimetric change.

Atrophy in the optic tracts considerably antedates that in the optic nerves, where the fibres may be preserved by their retinal ganglion cells for some years after complete functional blindness has occurred.

Cushing and Walker [1] state that in 20 per cent. of patients showing pronounced neighbourhood symptoms there is no demonstrable perimetric change.

It will be gathered that the chiasmal cross-roads are capable of considerable distortion by a growth in the interpeduncular space without the fields of vision being encroached upon.

They also show that cases in which normal fields were plotted shortly before death, have exhibited an extraordinary degree of deformation and elongation of the chiasma on post-mortem examination. They conclude, therefore, that an existent, clear-cut bi-temporal hemianopia is an evidence of a medial lesion most often due to a tumefaction of the hypophysis or its stalk, but that the reverse argument does not hold, that the absence of this characteristic defect, or, indeed, of any defect whatsoever in the fields, necessarily speaks against a primary pituitary or interpeduncular growth.

Of eighty-one cases of pituitary disease exhibiting field defects fourteen were acromegalics.

Ophthalmoscopic Changes.—The most common ophthalmoscopic abnormality is a varying degree of optic atrophy, and this is of a primary rather than a consecutive type.

[1] *Brain*, 1914, xxxvii., 341.

It is produced by direct pressure upon the nerve, and by this means the subarachnoid space of the nerve sheath is cut off from the general cerebral subarachnoid space, and so is protected against an increase of intra-cranial pressure should such occur, with the result that papillœdema is of unusual occurrence (see p. 16).

Cushing and Walker say in a few cases "a low grade of œdema, occasionally with new tissue formation, has been

FIG. 65.—To show the decussation of the optic nerve fibres at the chiasma, from a case in which the left eye had been removed some years previously. (Gordon Holmes.)

superimposed on a primary atrophy, when intra-cranial pressure has become extreme and the nerve sheaths have not been occluded by the growth."

Uhthoff finds active changes in the nerve head to be of more common occurrence; thus he finds either "choked disc" or optic neuritis to be present in 24 per cent. of cases without acromegaly or trophic disturbances, dystrophia adiposo-genitalis, etc., and in 11 per cent. of cases with such disturbances.

Fisher [1] looks upon primary optic atrophy, and not papill-œdema, as the feature of the disease.

Exophthalmos of a low degree is not infrequent; amongst ninety-one cases Strzeminski [2] found it present in seventeen, but believes it is more common than this. Cushing states that some degree of exophthalmos has been shown by almost all of the patients with tumour; it is rare in the absence of a definite growth. He looks upon it as due to obstruction of the flow in the cavernous sinus.

Affections of the ocular nerves are of common occurrence, and of them the third is most often affected; the sixth is much less often involved. In Uhthoff's cases the third was affected four times as frequently as the sixth. Hertel [3] says the sixth nerve is very rarely affected, but the third is frequently.

This preponderance of the involvement of the third nerve over the sixth is the more significant from the high vulnerability of the latter in all sorts of intra-cranial lesions.

Nystagmus occurred in about 4 per cent. of Uhthoff's cases.

INFANTILE SCURVY (BARLOW'S DISEASE).

In this disease, at a time when spongy bleeding gums, hæmaturia, subperiosteal hæmorrhages, and other symptoms occur, bleeding may also take place under the periosteum or into the tissues of one or both orbits.

It is usually a late symptom, and Barlow has reported a case in which it was the only symptom of the disease. A committee of the American Pediatric Society, as a result of the investigation of 379 cases of the disease, found proptosis to be present in forty instances.[4]

It usually comes on suddenly, the eye being pushed forwards and somewhat down and outwards, the common direction for an uncontrolled proptosis. The fit of crying by which its development is accompanied is effect rather than the cause.

[1] *Trans. Ophth. Soc. U.K.*, 1911, xxxi., 91.
[2] *Archiv. d'ophthal.*, 1897, xvii., 108.
[3] v. Graefe's *Archiv. f. Ophth.*, 1895, xli., 187.
[4] *Boston Med. and Surg. Jour.*, 1898, cxxxviii., 605.

If the blood infiltration transgresses the orbital fascia, ecchymosis of the lids occurs ; it may take the form of a purple line along the orbital margin or a bulky infiltration of the tissues.[1] When bleeding takes place from any cause into so poorly vitalised a tissue as fat it is slow in absorbing, and Holmes Spicer [2] has shown that the prominence of the eyes in these cases takes long to disappear. He quotes a case in which, after seven months, one eye was still abnormally prominent.

Cases of unilateral proptosis in healthy new-born infants have been reported by Borland [3] and Crawford,[4] due, apparently, to hæmorrhage into the orbit during birth, and followed by complete recovery.

KERATO-MALACIA.

This is a distinctive disease of the cornea which usually occurs in infants under one year of age who are seriously ill as a result of improper feeding.

The subjects of the disease have almost invariably been fed on starchy foods with an insufficiency of fresh milk, and have a wizened, dusky appearance ; in fourteen out of thirty-one cases there was a fatal termination.[5]

First one eye then the other is involved ; the lid margins are covered with sticky shreds of meibomian secretion ; the conjunctiva becomes dry, wrinkled, and greasy-looking, and is not moistened by the tears, and foam-like patches are developed on it. The cornea is dry, lustreless, and cloudy, and ultimately becomes entirely disintegrated. A striking feature is the almost entire absence of signs of inflammation throughout the course of the disease.[6]

At one time I examined the eyes of a considerable number of rats which were being experimented on by Professor Gowland Hopkins by being fed upon a diet which was free of the fat soluble vitamine. Many of them developed a condition of the

[1] Stephenson, *Proc. Roy. Soc. Med., London*, 1914–15, Section Dis. of Child., viii., 44–47.
[2] *Trans. Ophth. Soc. U.K.*, 1892, xii., 36.
[3] *Lancet*, 1904, ii., 1344.
[4] *Lancet*, 1904, ii., 1450.
[5] Kapuscinski, v. Graefe's *Archiv. f. Ophth.*, 1912, lxxxii., 229.
[6] Holmes Spicer, *Trans. Ophth. Soc. U.K.*, 1893., xiii, 45.

cornea which appeared to be similar to kerato-malacia as it occurs in children. The condition has recently been carefully investigated by Stephenson and Clarke [1] and McCollum and Simonds.[2]

The former investigators conclude that the condition directly attributable to dietetic deficiency is a predisposition to bacterial infection of the cornea, leading to purulent symptoms and destruction of tissue. They show that the eye disease is by no means a constant precursor of death in these rats, but that in every case of corneal disease in which it was attempted a cure was effected by the replacement of the fat soluble factor. The latter investigators, also working with rats, definitely associated xerophthalmia with the absence from the diet of fat soluble vitamine. They say : " There are, then, two deficiency diseases in the sense in which Funk employed this term. One of them is polyneuritis—the other, we believe, is the syndrome described above, in which the two most prominent features are emaciation and xerophthalmia."

Holmes Spicer has seen a similar condition of the cornea in a dog fed exclusively on biscuit, in which a meat diet produced an extraordinarily rapid cure.

[1] *Biochem Jour.*, 1920, xiv., 502.
[2] *Jour. Biol. Chem.*, 1917, xxxii, 181 and 347

CHAPTER V

Syphilis—Gross tuberculous lesions—Miliary tuberculosis—Cerebro-spinal meningitis—Pyæmia and septicæmia—Infective endocarditis—Facial erysipelas—Gonococcal eye affections—Eye affections in dysentery—Tetanus—Diphtheria—Leprosy.

SYPHILIS.

Lesions affecting the eyes or their external musculature are common in both the congenital and the acquired disease, they may occur as a manifestation of intra-cranial syphilitic disease or as a local manifestation of general systemic infection.

A primary syphilitic chancre occasionally occurs on the conjunctiva, especially on that of the lower lid. It is followed by the usual constitutional manifestations.

The chancre is generally larger and is less indurated than is usual in genital chancres, the lymphatic glands, especially the pre-auricular and submaxillary, are much enlarged; they are not so firm and shotty as are those in the groin in genital chancres.

There is some evidence [1] to show that, should the patient develop interstitial keratitis—a rare disease in acquired syphilis, and, unlike its counterpart in congenital syphilis, often unilateral [2]—it is more likely to develop in the eye which has been the site of a primary chancre than in the opposite eye.

I have once seen the lachrymal sac the site of a primary chancre, it was as if it had been injected with plaster of Paris; there was no ulceration or excoriation or any abnormality to be seen at the punctum or inner canthus; all the usual constitutional signs followed, and cicatrisation was followed by troublesome epiphora. Previously there had been no trouble of any sort with the eye, and it seems all but certain in this case that the spirochæte obtained entrance to the body through an intact mucous surface.

[1] Treacher Collins, *Roy. Lond. Ophth. Hosp.* (*Moorfields*) *Reports*, 1906, xvi., 16.
[2] Fisher, *Trans. Ophth. Soc. U.K.*, 1908, xxviii., 59.

INTERSTITIAL KERATITIS.

There are a number of diseases of the cornea to which the name interstitial keratitis, used in its anatomical sense, is applicable ; the term, however, has come to be applied, without qualification, to a disease which is a very sharply defined entity as regards incidence, morbid appearances, and clinical course, and for this disease there is, I believe, a single cause, and that is syphilis ; and whilst it very occasionally arises after acquired infection, it is almost invariably due to the congenital disease.

It is a disease of the young, and the years between five and seventeen will include a large majority of the cases. I have, however, seen it develop in its typical form in a woman of thirty-nine who had Hutchinson's teeth and was deaf, and occasionally an infant is born with the disease established. Of the sixty-four cases which were so carefully investigated by Hutchinson [1] nine were under the age of five, and the sex incidence showed a marked preponderance of females in the proportion of 1·8 to 1. It is very common to find other undeniable signs of the congenital taint, *e.g.*, a characteristic facies, scars, deafness, Hutchinson's teeth, etc. ; and if the child be stripped, synovitis of the knees, tibial nodes or curved tibiæ are not infrequently found, though both the patient and the mother may be ignorant of their existence.

On the other hand, it is not very rare to find no clinical evidence of the congenital disease other than the eye condition. Hutchinson's teeth are by no means always present, but I believe it to be true that a patient in whom they are present will, sooner or later, certainly suffer from interstitial keratitis.

It is of interest here to refer to the mortality amongst the children of those who are the subject of congenital syphilis as evidenced by the presence of interstitial keratitis. Hutchinson found that fifty-three such mothers bore, between them, 371 children, and that of this number 179 only survived. He states : "There can be little doubt, despite the many fallacies to which statistics expose us, that this rate of mortality is very high." Treacher Collins [2] found that twelve such women

[1] *Roy. Lond. Ophth. Hosp. Rep.*, 1857–9, i., 191, 226 ; 1859–60, ii., 54.
[2] *Roy. London Ophth. Hosp. Reports*, 1903, xv., 208.

had thirty-four living children, of whom twenty-five were presumably healthy and fourteen were certainly so. It is clear, therefore, that women the subjects of congenital syphilis may certainly have healthy children, free from all taint of the disease. He states: "The difference between the average infant mortality in London (16 per cent.) and amongst the grandchildren of those who have had primary syphilis (36·6 per cent.) remains very marked, so as to make it impossible to avoid the inference of the presence of some dystrophic influence."

It has been shown by Harman,[1] who examined the knee-jerks of 100 normal children and 100 children who had had interstitial keratitis, that there was no deficiency in the knee-jerks of the latter group.

In Acquired Syphilis.—Interstitial keratitis does, in a few cases, result from acquired syphilis.

The interval between infection and the development of the corneal disease may vary from four-and-a-half months [2] to twenty years.[3] 36 per cent. of cases occur in the second year,[4] and whereas in the congenital disease both eyes are always involved, the disease is frequently unilateral where the infection is acquired.[5]

Iritis.—This occurs in small infants in congenital syphilis, or soon after infection in the acquired disease.

The variety occurring in congenital cases was studied in twenty-three cases by Johnathan Hutchinson.[6] He showed that it was much more common in female than in male children; that the average age of onset was five-and-a-half months, the oldest of his twenty-three cases being sixteen months; that in about one-half the cases it was unilateral; that the signs of inflammation are slight, but the effusion of lymph is usually free. It may be said that if a small infant who shows no signs

[1] *Ophth. Review*, 1903, xxii., 241.
[2] Lawford, *Trans. Ophth. Soc. U.K.*, 1900, xx, 68.
[3] Terson, *Recueil d'Ophthal.*, 1899, 23.
[4] Verhaeghe, *Gazette des hôpit.*, 1904, lxxvii, 1141.
[5] Fisher, *Trans. Ophth. Soc. U.K.*, 1908, xxviii, 66; Carpenter, *Trans. Amer. Ophth. Soc.*, 1906–8, xi. 584.
[6] "Syphilitic Disease of the Eye and Ear," 1863, 1.

of acute illness develops iritis, it is almost undeniable evidence of congenital syphilis.

With regard to the effect of treatment Hutchinson says : " I have but limited faith in mercurial treatment as a prophylactic either against this or any other of the phenomena of infantile syphilis."

He states that in many of the cases the patients had been previously under treatment by mercury for other symptoms of hereditary syphilis, and that in five instances in the adult he had seen syphilitic iritis set in during actual ptyalism from mercury.

It is here convenient to state my conviction, that neither mercury nor any of the salvarsan compounds will prevent the onset of interstitial keratitis, or the other eye symptoms of congenital syphilis ; it is hardly to be expected, then, that they will bring about a cure when the disease is established.

I have seen an infant, the child of a trained nurse, which developed severe interstitial keratitis at the early age of three years, and this in spite of the fact that it had been given continuous treatment by mercurial inunctions since within a week of its birth.

Further, interstial keratitis in congenital syphilis invariably affects both eyes, but it is usual for there to be a greater or lesser interval between the time of their involvement ; nevertheless it is undoubted, that no form of treatment, however vigorously prosecuted, will prevent the onset of the disease in the second eye.

In the acquired disease iritis comes on during the secondary stage, usually within six months of the date of infection. In many cases it shows characteristic features in that buff-coloured nodules appear along the pupillary margin of the iris or, less often, at its base, but never in the intervening portion. In a good many cases, however, there are no features which are in any way distinctive.

Choroiditis.—This occurs in two chief forms, in the one there are numerous, quite isolated spots or areas, which are most numerous towards the periphery of the fundus. During their active stage, owing to coincident exudation into the vitreous,

they are seen dimly as very hazy, yellowish areas ; later, when complete subsidence has occurred, they remain as discrete, circular, white spots, surrounded and partly overlain by pigment which has undergone proliferation. This variety is seen most often in congenital syphilis, and is often associated with interstitial keratitis.

The second variety also is seen most often in congenital syphilis. In it there is a widespread, diffuse involvement of the choroid, the overlying retina being seriously involved, and consequently the term chorio-retinitis becomes appropriate. After the acute stage has subsided, the fundus is seen to be the seat of a widespread pigmentery disturbance, with irregular areas of choroidal destruction scattered over it ; more or less optic atrophy is evident, the retinal vessels may be greatly constricted, the retina invaded by pigment which has migrated into it from the choroid, and impairment of sight, which is often especially evident at night, is usually present.

Retinitis.—In a few cases the retina is so much chiefly and primarily implicated that the term syphilitic retinitis is properly applied to it. The whole retina, but especially its central part, is œdematous, swollen, and opaque-looking ; the disc edges are completely obscured ; the veins are much engorged and tortuous ; hæmorrhages are scanty.

The onset of the symptoms is often rapid, and there is profound loss of sight.

As the condition subsides, slight pigmentary infiltration of the retina is seen, the vessels are reduced in size and show marked perivascular white lines, the disc is partly atrophied, and day blindness may occur.

The condition is very resistant to treatment.

Gummatous infiltration of the tarsus, sclerotic, bones and periosteum of the orbit may occur, and in the last case proptosis, ocular paralysis and lachrymal obstruction may result by involvement of the corresponding structures.

Optic Disc Changes.—Active changes may occur in the optic disc as a result of syphilis, in the entire absence of any discoverable clinical evidence of intra-cranial involvement, either at the time or subsequently. Such cases are probably due either

FIG. 66.—Sections through the optic nerve at the levels indicated to show the distribution of the degeneration of the fibres; in the small diagrams alongside the best preserved bundles are indicated. There is diffuse degeneration in the right nerve, chiefly in the uncrossed fasciculi; in the left degeneration is less diffuse and is chiefly confined to crossed fasciculi, the condition therefore probably caused an original homonymous hemianopsia. From a man aged thirty-three who died of a malignant hypophysial adenoma with an interpeduncular cyst. His sight had been failing for three years and he had been totally blind in the right eye for six months. (After Cushing and Walker.)

to a syphilitic process in the nerve itself, or in some cases to gummatous periostitis at the apex of the orbit. They are not uncommonly unilateral, and slight, though definite pain is complained of on moving the affected eye; two important points of distinction from the changes which develop in the optic discs as a result of cerebral disease.

The onset, in my own experience, is within a year of infection, and in two instances I have seen it come on whilst the patient was actually undergoing a course of antisyphilitic treatment. In one of them the second eye became involved six weeks after the first, whilst the patient was in hospital undergoing a continuation of the treatment on account of the first eye.

As showing the frequency with which changes in the optic papilla are associated with cerebral syphilis, the following figures are compiled from Uhthoff's 100 cases:—

In fifty-two of them the fundi were normal; in eight, other changes were present, and in forty there were changes in the optic discs. Of these forty, fourteen exhibited a primary optic atrophy, and in the remaining twenty-six either papillœdema or atrophy secondary to it was present.

Optic Atrophy.—Syphilis is responsible for a very large proportion of all cases of optic atrophy, whether this occurs as a complication of general paralysis, tabes, meningitis, gumma of the brain or local eye disease.

In addition, however, it is probable that primary optic atrophy may occur as an independent parasyphilitic manifestation, and quite apart from other parasyphilitic disease.

Cases are reported by Read Wilson;[1] and McIntosh, Fildes, Head and Fearnsides,[2] in their article on parasyphilis of the nervous system, say: "No one can, therefore, doubt that primary optic atrophy can occur as a parasyphilitic phenomenon alone, or in combination with primary degeneration of the lateral or posterior columns of the spinal cord."

Paralysis of the Ocular Nerves.—The most common cause of paralysis of the ocular nerves in syphilis, if parasyphilis be excluded, is probably a direct involvement of them by gummatous disease in the orbit, or a basal syphilitic meningitis.

[1] *Brain*, 1912, xxxv., 173.
[2] *Brain*, 1913—14, xxxvi., 1.

Less frequent causes are cerebral gumma, syphilitic neuritis of the nerve trunks, or nuclear degeneration from disease of the supplying vessels.

Whilst ocular palsies arise in many different ways, some form of syphilitic disease is by a long way the most common single cause. Thus, of 141 cases of ophthalmoplegia collected by Collins and Wilde,[1] at least one-third were due to syphilis.

Uhthoff [2] analysed minutely 100 cases of cerebral syphilis; amongst these the third nerve was involved in thirty-four cases: fifteen times unilaterally, fifteen times bilaterally, and four times unilaterally with crossed hemiplegia due to involvement of the crus cerebri in the interpeduncular space. The sixth nerve was involved sixteen times: eleven times bilaterally, four times unilaterally, and once unilaterally with crossed hemiplegia. The fourth was involved unilaterally four times and bilaterally once. The fifth was involved in fourteen cases, all unilaterally.

In some cases the third nerve is only partly affected, and then ptosis is the commonest manifestation.

Of sixty-two cases of complete third nerve paralysis in cerebral syphilis Uhthoff found that it was:—

Unilateral, without hemiplegia, in nineteen cases.
Bilateral, without hemiplegia, in thirty-five cases.
Bilateral with crossed hemiplegia in eight cases.

Of seventeen of these cases which came to autopsy in nine years the optic papilla, nerves, chiasma or tracts were involved in fourteen.

Ocular palsies are rarely seen in congenital syphilis, but the nerves may be involved in a periostitis, or they may be the seat of a gummatous infiltration. Lawford, in reporting two cases,[3] says: "Very few authors to whose works I have referred mention the occurrence of ocular palsies in connection with congenital syphilis." Cases are reported by Wells, Nettleship,[4] Hutchinson.[5]

[1] *Brit. Med. Journ.* 1891, ii., 475.
[2] v. Graefe's *Archiv.* f. Ophth., 1894, xl., i., 43.
[3] *Ophth. Review*, 1890, ix., 97.
[4] *Trans. Path. Soc.*, 1881, xxxii., 13.
[5] "Syphilis," 1887, 208.

GROSS TUBERCULOUS LESIONS.

Gross tuberculous disease of the eye is occasionally seen, due to a blood infection of some part of the uveal tract.

Severe irido-cyclitis occurs, there is exudate into the vitreous which causes a yellowish pupillary reflex, the retina is detached, and ultimately the sclerotic is softened and gives way before the intra-ocular contents, and complete destruction of the eye ensues (Fig. 67).

Besides these cases, however, some observers attribute many

FIG. 67.—Showing gross tuberculous disease of the iris and ciliary body. The anterior chamber is filled with exudate and the mass of granulations (*A*) have perforated the globe.

of the numerous cases of gross solitary choroiditis that are seen to the tubercle bacillus, but, as it seems to me, on quite insufficient grounds.

This form of disease always gets well in the course of time, leaving a large pigmented scar in the choroid. Apart from miliary choroidal tubercles, I believe tuberculous disease of the eye is quite rare.

Peter [1] examined ophthalmoscopically the eyes of 320

[1] *Amer. Jour. of Ophth.*, 1916, xxxiii., 105.

patients in the last stages of pulmonary tuberculosis, and in no single case did he find a tuberculous lesion of the uveal tract.

I suggest the following as a probable explanation of some of these cases, though I can offer no direct evidence in its support:—

That at times minute emboli occur in the blood stream of individuals in health, or who are at most but slightly indisposed.

Such minute emboli may lodge in the vessels of any of the tissues of the body, except the eye—not excluding most parts of the brain and heart—without giving rise to discoverable lesions, or even disturbing symptoms; should such an embolus, however, lodge in any of the intra-ocular vessels, whether those of the retina or choroid, the resulting obscuration of vision cannot be overlooked, and so the actual lesion which is visible in this organ alone of the whole body is discovered.

Such an occurrence in the retinal artery is well recognised under the term "embolism of the central retinal artery," and it is significant that in many or most such cases no source of the embolism is discovered, and I suggest that many of the cases of choroidal lesions which by some are attributed to the tubercle bacillus, are in fact brought about by the lodgment of an embolus of unknown source in one of the vessels of the choroid.

MILIARY TUBERCULOSIS.

In miliary tuberculosis tubercles are often developed in the choroid and are then of great diagnostic value, seeing however, that they are by no means always present in this disease, their absence is of little negative value.

Incidence in Tuberculous Meningitis.—There is an extraordinary variation in the estimates of various authors as to the frequency of choroidal tubercles in this condition; some have found them in all cases, and some have said that they seldom if ever occur. These wide discrepancies arise from two causes.

First, a thorough examination of the fundus in the subjects of this disease is often difficult and unsatisfactory, so that figures based on ophthalmoscopic investigation alone are sure to indicate an incidence which is less than the truth.

Secondly, choroidal tubercles are developed late in the disease; consequently, unless the stage at which the examinations are made is taken into account, the estimates are sure to be misleading; the largest number of cases would be found were all the examinations made immediately before death.

Tooke found seven cases of choroidal tubercles amongst seventy-three cases of tuberculous meningitis, but in no case were they present, he states, earlier than three days before death.

Choroidal tubercles are readily seen by the aid of a lens or indeed with the naked eye in the post-mortem room; with a view therefore of obtaining an absolute estimate of their frequency, I have examined the eyes of thirty-three patients suffering from miliary tuberculosis in this way; all but two of them had tuberculous meningitis. The average age of the patients was six years, the oldest being twenty and the youngest five months. Of these thirty-three patients, ten, *i.e.*, 29 per cent., had one or more tubercles in one or both eyes. It may, then, be said that they occur in rather less than one-third of cases.

I have seen a single tubercle present in one eye only, with none in the opposite eye, and I have counted as many as forty-seven discrete tubercles in a single eye.

In the great majority of cases in which tubercles are present in the choroid, they will also be found in the meninges, but this is not necessarily so. I have seen two cases where choroidal tubercles were present, in which the viscera in general were plentifully scattered, but none were discoverable on most careful examination of the meninges.

Whilst in general it is true that when choroidal tubercles develop meningitis is also present, and so it comes about that their presence usually precedes death by a short time only, nevertheless in those rarer instances of miliary tuberculosis where choroidal tubercles develop but the meninges are free of disease either throughout or until a later stage, the presence of tubercles in the choroid may precede death by a longer period.

The longest time that I can be sure of having seen them before death is thirty-two days, but no doubt this period may be exceeded.

Fig. 68.—A section through a large choroidal tubercle from a case of tuberculous meningitis. In the centre is an hæmorrhagic area, and several giant cells (*B*) are seen. During life the tubercle had somewhat the appearance depicted in Fig. 69, *i.e.*, it was pale in the centre with a pigment fringe around; it gave the impression that the tubercle was so prominent that it had protruded through the pigment epithelial layer of the retina so that the ragged free edge of the latter appeared as a fringe. The edge of this pigment lay is seen (*A*).

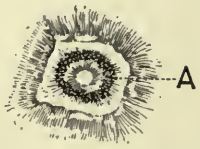


Fig. 69.—A drawing made during life of the choroidal tubercle shown in section above. *A*. Points to the pigmentary fringe caused by the protrusion of the summit of the tubercle through the pigment epithelium.

Barlow [1] states that in sixteen cases of tubercle of the choroid three showed the presence of tubercles in other organs, but none in the meninges.

[1] Allbutt's "System of Medicine," 1910, vii., 217.

Other cases showing this to be true are reported by Randolph and Schmeisser,[1] Lawford [2] and Warner.[3]

It is evident that individual tubercles are rapidly formed. I have seen one become visible to the ophthalmoscope in five hours; Warner has seen them develop within a day, and Marples [4] has seen one develop within four hours. Of six cases examined histologically by Lawford, two showed the presence of plentiful bacilli, but he was unable to find them in the remaining four cases. Their average diameter is about 1 mm., but they vary a good deal in size.

Some slight œdema of the optic disc, with blurring of its edges, is often seen in tuberculous meningitis, but a swelling of the nerve head at all comparable with the papillœdema of a cerebral tumour is rarely seen. Tooke states: "Early inflammatory changes about the nerve, described by some as perineuritis, by others as a perineural œdema, were recorded in thirty out of the seventy-three cases examined." Hughlings Jackson [5] says: "In tuberculous meningitis the swelling is slight, not extensive, it is even and merges into the fundus; the disc is succulent-looking; there is not time possibly for further development.'

CEREBRO-SPINAL MENINGITIS.

The ocular lesions associated with this disease may be divided into those which are to be seen within the eye itself, and lesions which manifest themselves as functional defects.

Different epidemics show a varying incidence of ocular lesions.

The most important changes which occur are :—

(1) Metastatic intra-ocular infections, *i.e.*, conjunctivitis, iritis, choroiditis, retinitis or panophthalmitis.
(2) Papillœdema.
(3) Amaurosis without ophthalmoscopic signs.
(4) Ocular palsies and nystagmus.

[1] *Trans. Am. Oph. Soc.*, 1916, xiv., 589.
[2] *Trans. Oph. Soc. U.K.*, 1886, vi., 351.
[3] *Trans. Oph. Soc. U.K.*, 1883, iii., 127.
[4] "Ophthalmoscope," 1912, x., 561.
[5] *Trans. Oph. Soc. U.K.*, 1881, i., 64.

Incidence.—Amongst 100 cases Heine [1] found ocular complications in twenty-seven; Vinsonneau [2] found two cases amongst twenty of the disease; Randolph [3] found seven cases of well-marked intra-ocular change amongst thirty-five cases, and in nineteen other cases there was marked engorgement of the retinal veins, and he states that this last was a feature of the particular epidemic.

(1) **Metastatic Infections.**—Of the metastatic infections the least important is a conjunctivitis which usually is of no great severity, although it has occasionally been serious; in two out of six cases McKee [4] isolated the meningococcus from the discharge.

The intra-ocular metastases are much more serious; they are not common nor are they excessively rare; they occur in sporadic cases as well as in epidemics. At first there is a yellowish reflex from the pupil owing to infiltration of the vitreous, iridic adhesions quickly form, and gradual shrinkage of the globe occurs. To the condition of the eye which results, the term "pseudo-glioma" is sometimes applied from its simulating the appearance of a glioma of the retina. The condition is usually unilateral, and according to Randolph is most common in the right eye. The signs of inflammation of the eye are slight, vision is always lost.

(2) **Papillœdema** is not of frequent occurrence: Randolph found it in 17 per cent. of his cases; Batten [5] says optic neuritis is rare; Barlow and Lees [6] found three cases only amongst forty-two cases of the disease.

Terrien and Boudier [7] examined three cases where death occurred within the first week, and in whom the only ophthalmoscopic sign was hyperæmia of the papilla.

Their conclusions were:—

(1) Meningeal infection spreads along the sheath of the optic

[1] Berlin, *Klin. Wochenschr.*, 1905, xlii., 772.
[2] *Archiv. d'Ophth.*, 1914, xxxiv, 349.
[3] *Bullet. of the Johns Hopkins Hosp.*, 1893, iv., No. 32, 59.
[4] *Ophth. Record*, 1908, xvii, 438.
[5] Garrod and Thursfield, "Diseases of Children," 1913, 747.
[6] Quoted Batten; Albutt's "Syst. of Med.," 1910, vii., 174.
[7] *Archiv. d'Ophth.*, 1909, xxix., 301, and 1910, xxx., 214.

nerve in the same way and at the same period as on the surface of the brain and spinal cord.

(2) It begins as an inflammation of the arachnoid and pia, and may go on to resolution or provoke lesions in the parenchyma of the optic tracts.

(3) The process is a diffuse perineuritis extending the whole length of the optic tracts, but is most intense at the optic canal. In some cases the nerve suffers from a secondary interstitial neuritis leading to disappearance of nerve bundles and optic atrophy. This secondarily developed interstitial neuritis may explain cases in which blindness has supervened during convalescence without ophthalmoscopic change.

(3) **Amaurosis without Ophthalmoscopic Signs.**—Dr. Hugh Thursfield tells me, from his large experience at the Great Ormond Street Children's Hospital, that a very large proportion of infants show evidence of great loss of sight during the illness. The pupils remain active to light stimulus and the fundi are normal.

There is no doubt that many of the cases of " acute amaurosis of infants " (p. 249) are of this nature.

In the majority of cases sight is completely restored, sometimes quite suddenly, and this may happen after the blindness has persisted for many weeks.

Batten [1] says: " The blindness which is present in this disease is a striking feature; it is often present as an early manifestation and is complete. It is not due to optic neuritis or atrophy; optic neuritis is but rarely seen, the optic discs and the vessels of the fundus are generally perfectly normal.

" The child will sometimes remain perfectly blind after general recovery has taken place; in some cases the blindness will persist for many weeks and then sight may be recovered completely; the longest period that I have seen a child blind and recover good vision is four months."

(4) **Ocular Palsies and Nystagmus.**—Paralysis of some of the ocular muscles is of common occurrence, and according to

[1] Garrod and Thursfield, " Diseases of Children," 1913, 749.

Randolph[1] it most frequently affects the right eye; thus, of thirty-five cases, divergent strabismus was present in eight, and in each case it was the right eye that was affected; he points out that this tendency to right-sided lesions has been noted by others.

The paralyses are probably due to the involvement of the nerve trunks at the base of the brain.

Nystagmus is sometimes seen. In some severe cases corneal ulceration develops owing to incomplete closure of the lids, the lower part of the cornea remaining exposed, and blinking being largely in abeyance In such cases it is the exposed part only which becomes ulcerated, and it consequently has a horizontal upper edge, corresponding with the lower margin of the upper lid, both eyes are usually affected; perforation may occur. If the child survives, the resulting bilateral nebulæ with sharp-cut horizontal upper limits, are left to tell the tale to those who can read, of a serious and prolonged illness, during which the patient lay in an unconscious state with the eyes only partly closed.

PYÆMIA AND SEPTICÆMIA.

In these conditions where there is a generalised infection of the blood whatever the original source, retinal hæmorrhages are almost invariably present towards the end of the illness, and, as in infective endocarditis, they are probably caused by the lodgment of infected emboli in the retinal capillaries.

These emboli may, as in the latter disease, lead to uni- or bi-lateral panophthalmitis, with consequent complete destruction of the eyeball, sometimes without the endocardium being involved.

There is little evidence of acute inflammation of the eye, the iris becomes discoloured, there is fibrinous exudation into the pupil, a yellowish reflex is obtained from the infected vitreous giving rise to an appearance to which the term pseudo-glioma is applied, and the eye shrinks and becomes blind; as mentioned elsewhere, this complication may occur in post-basic meningitis, it is also seen in other forms of meningitis.

[1] *Bullet. of the Johns Hopkins Hosp.*, 1893, iv., No. 32, 59.

Flemming [1] collects forty-two of this type of case, of whom only six died, and comments upon the comparative rarity of a fatal termination.

Bull [2] reports six such cases occurring during pneumonia.

INFECTIVE ENDOCARDITIS.

The common lesion of the eye in this disease is the presence of hæmorrhages into the retina, and these are so common as to

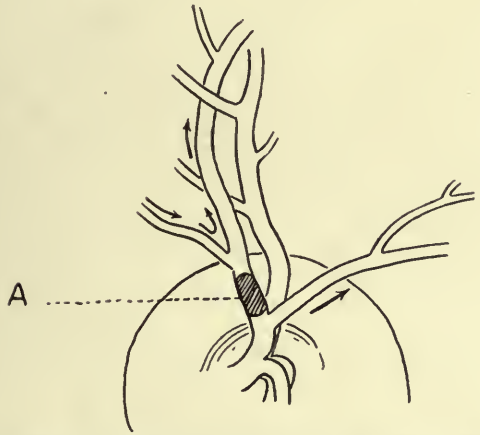


FIG. 70.—Showing the lodgment of an embolus in a branch of the retinal artery in infective endocarditis. From a man aged twenty-seven, under the care of Dr. Langdon Brown, who had been under observation in hospital for five weeks. He awoke an hour after having gone to sleep to find he could not see with his right eye. *A.* indicates the position of the embolus, and the arrows show the course of the "visible streaming" of the blood in the arteries, the direction of flow being reversed in one of them.

be usual. They occur at the same time as the petechial hæmorrhages which are so frequent in other parts, and have little value in diagnosis or prognosis. Of twenty-four cases of my own, sixteen were males and eight were females, the average age being 27·7 years. In eight of these cases no hæmorrhages were discoverable at the time of examination, but in very few cases does the retina remain free of hæmorrhages right up to the time of death.

[1] *Trans. Ophth. Soc. U.K.*, 1900, xx., 135.
[2] *Trans. Amer. Ophth. Soc.*, 1900, ix., 316.

The hæmorrhages are usually small and scattered and are often roughly circular in outline, they do not show the same preference for the central regions as do most other forms of hæmorrhage, no doubt from the fact that they represent minute emboli whose point of lodgment will depend upon their size.

Sometimes they appear as ordinary flame-shaped hæmorrhages in the region of the disc, sometimes they are large and infiltrate the perivascular sheaths, sometimes they overlie the macula and, like other subhyaloid hæmorrhages, cause erythropsia, and sometimes they have pale nucleus-like centres such as are seen most frequently in leukæmia.

Occasionally other ocular complications arise. Sometimes emboli appear to lodge in the ciliary arteries greatly disturbing the choroidal circulation; there is rapid and great loss of sight, the retina has a raised and uneven surface, is very hazy and œdematous, and bleedings occur in its substance; if the patient survives, extensive pigmentary changes develop in the choroid.

Sometimes there is a sudden serious loss of sight from lodgment of an embolus in the central retinal artery or one of its large branches.

Fig. 70 was drawn from a man of twenty-seven who developed an embolism in a branch of his right retinal artery whilst he was in hospital for infective endocarditis. At ten o'clock he was as well as usual; he awoke at eleven o'clock with "a funny feeling" in his head and found he couldn't see with his right eye. Fifteen hours later there was the milky œdematous appearance of coagulation necrosis, affecting the part of the retina supplied by the artery. The arteries were greatly reduced in size, and the contained column of blood was broken up into short blocks of red cells with intervening short intervals of clear plasma, the so-called "cattle truck appearance." The blood could thus be seen to be travelling along the arteries in a slow stream in the direction indicated by the arrows; in one branch it was travelling in a reversed direction.

It seemed that a collateral circulation between the artery and the next below was present, and the blood therefore came

down this vessel and was distributed along the other branches as indicated. This slow circulation was easily arrested by slight pressure upon the eyeball.

In most cases the emboli show no signs of being infective, but it happens occasionally that panophthalmitis with destruction of the eye, follows upon the lodgment of an embolus in which active organisms are present.

FACIAL ERYSIPELAS AS A CAUSE OF BLINDNESS.

In some cases of facial erysipelas the infection spreads to the orbital tissues, producing orbital cellulitis and complete loss of vision in one or both eyes, and a similar result may ensue from cellulitis of the orbit produced in other ways. It often happens that the actual onset of the blindness is overlooked from the fact, that during the acute stage the lids are so greatly swollen that it is not possible to expose the cornea, and it is only when this swelling has subsided that the loss of sight is revealed. There is marked proptosis, chemosis and limitation of movement.

Knapp [1] examined the fundi of a case throughout ; he found that the vision was completely lost in two days, and that hæmorrhages were freely scattered all over the fundi as a result of thrombosis in the retinal artery and veins. He showed [2] that of thirty-five cases the mortality was 29 per cent., and of those surviving, total blindness in both eyes occurred in 16 per cent., and in one eye in 60 per cent. Other cases are reported by Leber,[3] Williams,[4] Coggin, and others.

GONOCOCCAL IRITIS.

Having regard to the prevalence of gonorrhœa, iritis must be considered an uncommon complication of it ; at the same time it is probably the commonest cause of a primary acute iritis in an adult male.

It occurs only in the presence of a blood infection, and, consequently, those who are the subject of a first attack are

[1] *Trans. Amer. Ophth. Soc.*, 1883, iii., 573.
[2] *Archiv. of Ophth.*, 1884, xiii., 83.
[3] v. Graefe's *Archiv. f. Ophth.*, 1880, xxvi., iii., 224.
[4] *Boston Med. and Surg. Jour.*, 1883, cviii., 51.

usually in poor health, and will be found to have a raised temperature; in recurrent attacks, however, there is little constitutional disturbance.

On the other hand, I have notes of nine cases in which the gonococcus was obtained in pure culture in fluid withdrawn from the knee joint, in five of which the temperature was sub-normal throughout, and in a sixth case it exceeded the normal on four days only.

As gonococcal blood infections are greatly more frequent in males than in females, so is gonorrhœal iritis quite unusual in women.

During the course of twelve years I was able to collect 131 cases of primary gonococcal blood infection at St. Bartholomew's Hospital; [1] of these 118 were in men, and thirteen in women.

It is unusual to find a case of iritis in which there has not been an antecedent arthritis, and it was this association which was responsible for many years for the diagnosis of rheumatic iritis which was usually attached to these cases.

Iritis does not occur as a complication of rheumatic fever.

Date of Development.—In seventy-nine of my cases in which the interval between the gonorrhœal infection and the onset of the arthritis was noted, it was less than a month in sixty-eight cases, and in ten cases in which the interval between the onset of the arthritis and that of the iritis was noted, the average length of time was six weeks. It sometimes happens that a patient has attack after attack of arthritis without any evident iritis, and later, perhaps several years after the first involvement of the joints, iritis is developed for the first time.

Recurrences of both arthritis and iritis are common, and apart from a fresh infection, they probably indicate the presence of organisms lurking in the genito-urinary tract.

Joints Involved.—Amongst the 131 cases referred to, 87 per cent. had the knee joint involved, 56 per cent. the ankle, 40 per cent. the shoulder, whilst the joints least often affected were the jaw, sterno-clavicular, and sacro-iliac.

In the primary attack of gonorrhœal iritis there is often a rather bright yellow, gelatinous-looking exudate in the anterior

[1] *St. Bartholomew's Hospital Reports*, 1912, xlviii., 87.

chamber, and when it occurs, it is almost pathognomonic of this form of iritis ; it is not seen in the recurrences.

In rare instances the manifestations of blood infection result from gonorrhœal conjunctivitis, as in ophthalmia neonatorum.

Endogenous Conjunctivitis.—In some cases of blood infection there is an injection of the conjunctival and episcleral vessels, a condition to which the term " metastatic gonorrhœal conjunctivitis " may be applied. Herrfordt [1] states that of 2,310 cases of gonorrhœa treated at the Copenhagen Municipal Hospital in the course of five years, this endogenous form of conjunctivitis occurred in twenty-three. Byers [2] states that in 30 per cent. of such cases the deeper coats of the eye were involved, and it is probable that a considerable proportion of cases diagnosed as endogenous conjunctivitis have been cases of iritis of so mild a degree that the more conspicuous signs, such as posterior synechiæ, have not developed.

EYE AFFECTIONS IN DYSENTERY.

In cases of dysentery affections of the eyes are by no means rare ; they take the form either of conjunctivitis or of iridocyclitis.

The conditions are due to infection through the blood stream, and are not due to the organism having been conveyed directly by the finger to the conjunctival sac. They may commence as a conjunctivitis, and iritis may afterwards be developed.[3] In most cases the eye symptoms are associated with arthritis of some of the joints, though this is not always so.

Thus, of twelve cases reported by Cosse and Delord,[4] eight suffered from joint affections ; and similarly four out of six cases reported by Kiep and Maxwell.[5] Of thirty cases of arthritis reported by Graham [6] thirteen suffered from affection of the eyes.

The eye symptoms came on at varying times after the onset

[1] v. Graefe's *Archiv. f. Ophthal.*, 1909, lxxii., 344.
[2] " Studies from the Roy. Victoria Hospital, Montreal," 1908, ii., No. 2, 23.
[3] Morax, *Annales d'Oculistique*, 1917, cliv., 45.
[4] *Annales d'Oculistique*, 1917, cliv., 33.
[5] *British Jour. of Ophth.*, 1918, ii., 71.
[6] *Proc. Roy. Soc. of Med.*, 1919, xiii., Section of Medicine, 23.

of the disease, but three weeks may be considered as about the average period ; the interval may be as short as twelve days (Kiep and Maxwell) or as long as eighty-eight days (Graham).

They and the arthritis are usually developed at about the same time, sometimes one and sometimes the other appearing first by a day or two. There does not appear to be any relation between the incidence of the ocular complications and the severity of the arthritis, for of Graham's thirteen cases with ocular complications, in seven the arthritis is described as being severe, and in six as being mild.

All accounts agree in describing the conjunctivitis as being of a mild type, with but little formation of pus or muco-pus. It affects the lower palpebral conjunctiva more especially (Cosse and Delord) ; it is quickly and completely cured by means of simple lotions. The iritis, too, is in general, of a mild type, and if treated early is quickly recovered from, but if neglected extensive synechiæ form, and much trouble may ensue.

The marked similarity between the foregoing articulo-ocular syndrome and that which results from blood infection in gonorrhœa can scarcely escape notice.

TETANUS.

In a few cases of cephalic tetanus the ocular muscles are the first to be involved, and may remain the only manifestation of tetanus for some days. These cases have been especially defined by Fromaget,[1] Worms,[2] and Courtois-Suffit and Giroux.[3]

In many of the cases the wound of infection has been in the orbito-ciliary region, an area which, from its prominence, is especially liable to contused wounds. It does not necessarily follow, however, that should tetanus arise from a wound in this situation, that it will be of the ophthalmoplegic type. Courtois-Suffit says : "In several cases of those in which tetanic ophthalmoplegia was most clearly defined the trauma was in the eyeball."

[1] *Archiv. d'Ophthal.*, 1894, xiv., 657.
[2] *Du tétanos bulbo-paralytique. Thèse de Lyon*, 1906, No. 15.
[3] "Les formes anormales du tétanos," Paris. 1916.

Sattler [1] reports the case of a man who sustained a penetrating wound of the cornea by a dirty wooden arrow. The eye was removed within twenty-four hours, but the patient died of acute tetanus in eight days.

Some only of the muscles supplied by the oculo-motor nerve may be affected, and in this case the levator palpebræ is the most frequent; the ophthalmoplegia is almost always seen on the same side as the wound, but the other side is involved later.

The fourth and sixth nerves are rarely involved, except in combination with the other nerves of the orbit.

With regard to the internal muscles of the eye, Albert [2] says that there is extreme myosis, and that the pupil does not react to light, but that—at any rate at first—the ciliary muscle is not affected.

DIPHTHERIA.

Diphtheritic conjunctivitis may be brought about by direct infection with the bacillus or as a result of extension from the nasal cavity, and it may take on one of two clinical courses.

In the one variety a false membrane is formed on the conjunctiva, which is easily peeled off leaving a raw surface, and which, with serum and simple local treatment, rapidly disappears, leaving no serious residue.

In a few cases, however, the tissues of the lids are involved and become greatly swollen and brawny, a thick false membrane forms which is rapidly reformed after removal, the cornea becomes ulcerated, and the eyeball is destroyed. In these cases, after removal of the eye, the thickening of the lids and the thick washleather-like false membrane may persist for years in spite of all forms of treatment, including serum, and is only cured by actually dissecting away the whole of the diseased tissues, the conjunctival cavity being thus obliterated.

In these cases the diphtheria bacillus is not demonstrable, at any rate after the first few days, and although the condition is here referred to, some of these cases are caused by the streptococcus and it may be that all are due to this organism;

[1] *Archives of Ophthal.*, 1918, xlvii., 64.
[2] *Etudes sur le tetanos cephalique. Thèse de Lyon*, 1890.

it has to be remembered that the xerosis bacillus is a normal inhabitant of the conjunctival sac, and that unless some care is exercised, it may be mistaken for the Klebs-Loeffler bacillus.

Paralyses.—Paralysis of some of the ocular muscles is a common sequel of diphtheria, it may affect the ciliary muscle or the extrinsic muscles.

Next to the soft palate the ciliary muscle is probably the commonest muscle to be involved in post-diphtheritic paresis or paralysis, though in small children its presence is not easily ascertained. Both eyes are affected. The date of onset is usually three or four weeks after the disease has commenced.

With regard to its duration, Ker says : "I have seldom seen it persist longer than five weeks, and its duration is usually much shorter; perhaps three weeks would be a good average."

The pupil is seldom involved, though a number of observers have described it as being somewhat dilated.

Of the extrinsic muscles the external recti are the most vulnerable, though the muscles supplied by the third nerve are often affected; strabismus and diplopia are a consequence.

The greatest number of cases is seen during the sixth and seventh week after the onset of the disease, and recovery is usually complete within twenty-one days.

If an adult patient is afflicted with post-diphtheritic paralysis, the presence of a squint combined with paralysis of accommodation and absent knee jerks may at first sight suggest locomotor ataxy.

LEPROSY.

Eye complications in leprosy are both frequent and severe. Of 277 lepers examined by Borthen [1] 12 per cent. were blind in one eye and 17 per cent. in both eyes. Kubert found the eye and its appendages involved in 75 per cent. of cases, and Jeanselme and Morax [2] found lesions of the globe in eleven out of fifteen cases.

Blindness is usually due to involvement of the uveal tract, and is twice as common in the nodular as in the anæsthetic variety of the disease (Borthen).

[1] "Die Blindenverhaltnisse bei der lepra," Christiania, 1902.
[2] *Annales d'Oculistique*, 1898, cxx., 321.

Calderaro,[1] who has investigated the histology of the disease, finds that bacilli are numerous and constant along the margins of the lids, but are rare on the posterior surface of the lids and are absent from the aqueous.

He believes the infection is conveyed to the eye by means of the fingers or handkerchief, that the entrance is through the epithelium of the cornea or conjunctiva, and the episcleral tissues at the limbus are the first to become involved. Thus he finds the first tissue changes in the episcleral vascular network in the form of a leprous cell infiltration about the vessels, with the formation of leprous nodules in the sclerotic; later this infiltration spreads to the anterior part of the uveal tract, iris, ciliary body and choroid.

Jeanselme and Morax state that the seat of election of the pathological changes is the sclerotic in front of the insertions of the muscles, and that conjunctival lesions are always secondary to subjacent disease of the sclerotic.

Clinical Manifestations.—Lagophthalmos is most common in anæsthetic leprosy, and ulcerations of the cornea occur which are due in part to the exposure consequent upon the lagophthalmos and in part to its anæsthetic condition.

An interstitial keratitis is also at times seen.

Two forms of iritis are described: one a plastic iritis having no characteristic features, the other resulting in the formation of a leproma at the base of the iris.

Infection of the ciliary body and anterior part of the retina and choroid is common, the posterior segment of the globe in large measure escaping.

It is this involvement of the deeper coats of the eye which is chiefly responsible for the blindness which so often ensues.

Leprosy is a rare disease in England, but cases with eye complications are reported by Treacher Collins [2] and Rockliffe.[3]

[1] *La Clinica oculistica*, 1909, 3437.
[2] *Trans. Oph. Soc. U.K.*, 1909, xxix., 223.
[3] *Trans. Oph. Soc. U.K.*, 1902, xxii., 151.

CHAPTER VI

Leber's disease—Amaurotic family idiocy (Tay-Sach's disease)—Congenital word blindness—Night blindness—Blue sclerotics—Ocular torticollis—Jaw blinking—Cyclic dilatation of the pupil—Abnormalities of the retinal vessels—Medullated nerve fibres.

LEBER'S DISEASE.

This is an hereditary disease characterised by the development of partial optic atrophy and serious permanent impairment of central vision, the peripheral visual fields being unaffected; there is no associated constitutional disturbance.

It was first described by Leber in 1871,[1] who believed that it was more frequent in neuropathic individuals.

Many members of a family may be affected; thus Leber collected fifty-five cases in sixteen families. Norris [2] reported a family of seven children all of whom were afflicted with the disease. In three generations of the same family fourteen individuals were affected ont of a total of twenty-two.

It was shown by Habershon [3] that the disease may involve at least five generations; it may, however, skip a generation, for in five out of Leber's sixteen families the disease was inherited through the mother, though she was not affected.

Sex.—Females are not exempt from the disease, but are affected much less often than males, in the proportion of one to nine according to Leber, though published cases would seem to show a less disproportion.

Age.—Leber's original statement was that the disease started within a few years of puberty between the ages of eighteen and twenty-three, and whilst this is the commonest period, many cases have been reported well outside these limits.

[1] *Archiv. für Ophth.*, 1871, xvii., ii., 249; "Graefe und Saemisch Handbuch," 1877, v., 824.
[2] *Trans. Amer. Ophth. Soc.*, 1880—84, iii., 673.
[3] *Trans. Ophth. Soc. U.K.*, 1888, viii., 196.

Thus Sedgwick,[1] so early as 1862, published the case of a man who became blind at the age of sixty and whose four sons lost their sight at the ages of fifty-six, forty-six, forty-six and forty-two.

Fuchs [2] published cases in three families whose ages ranged from twenty-one to fifty-seven, and Norris [3] two cases aged forty-nine and fifty. On the other hand, the average age of Norris's fourteen patients was sixteen years.

Course of the Disease.—The onset is usually rapid though not sudden, and whilst both eyes are always affected, they are but seldom involved simultaneously; it is, however, unusual for the interval before the second eye becomes affected to be so long as six months. After the first symptoms the sight fails rapidly for some days or weeks, and afterwards more slowly for several months.

Later some improvement generally occurs, so that ultimately the patient is usually able at least to get about alone, and in some cases recovery has been complete. Thus Nettleship [4] reports the case of a man whose vision was reduced to 6/60 in five weeks; eight months later improvement began to set in, until ultimately he could read the smallest type with ease. A brother and two cousins also had the disease, and one of the latter also completely recovered. Batten [5] reported a case in which the vision was restored to 6/6, although the discs were somewhat pale, and a number of other observers, Frost, Johnson Taylor, Lawford, have reported instances of complete recovery of sight.

It may be said that patients never go blind from Leber's disease, but that serious permanent impairment of vision is the rule.

The visual defect takes the form of a central scotoma for white as well as colours, which extends for about 7 degrees from the fixation point, the peripheral visual field remaining unconstricted (Fig. 71).

[1] Quoted Habershon; *Trans. Ophth. Soc. U.K.*, 1888, viii., 191.
[2] *Klin. Monats. f. Augen*, 1879, xvii., 332.
[3] *Trans. Amer. Ophth. Soc.*, 1880—84, iii., 355.
[4] *Trans. Ophth. Soc. U.K.*, 1903, xxiii., 109.
[5] *Trans. Ophth. Soc. U K.*, 1909, xxix., 141.

In the early stages a mild degree of change in the nerve head occurs, it takes the form of obscuration of the edges of the disc without obvious swelling; hæmorrhages or exudates do not occur: there is no change to which the term papillœdema can properly be applied.

When the acute stage is passed a mild degree of optic nerve

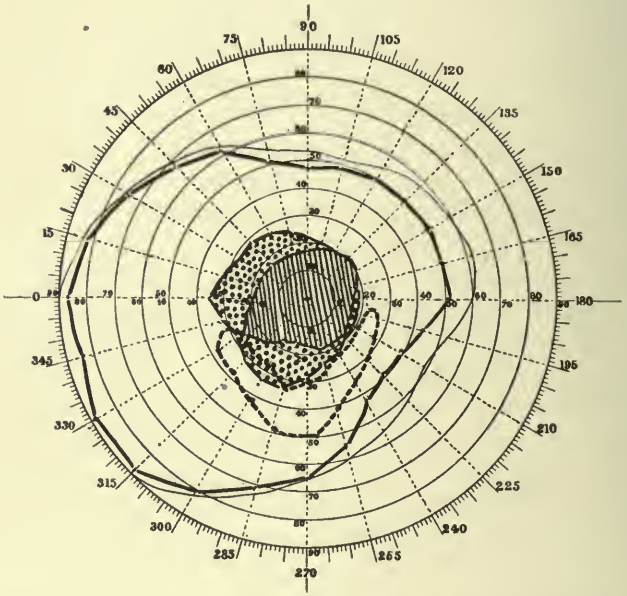


FIG. 71.—To show the defects in the visual fields in a case of Leber's disease. (Gordon Holmes.) Lined area = complete blindness to a 15m. m. white square. Dotted area = partial blindness to the same object. The broken line encloses the only area in which a 15 m.m. bluesqu are could be seen. The defects in the right eye were similar.

atrophy remains, the disc showing the characters of a secondary atrophy.

Fisher [1] suggests reasons for thinking that Leber's disease may be due to disturbances or excessive physiological activity of the pituitary body.

Thus he draws attention to the neuropathic tendencies in the

[1] *Trans. Ophth. Soc. U.K.*, 1916, xxxvi., 299.

two conditions, to the occurrence of subjective visual phenomena in each, and to the fact that both show certain connections with the sexual functions. The ophthalmoscopic appearances of the optic discs are similar both in the early and late stages, and he produces some X-ray evidence which receives support from Zentmayer [1] and Brunner [2] to show that changes in the pituitary fossa may be present in Leber's disease.

In conclusion he expresses the opinion "that when an opportunity offers to some observer, it will be proved that Leber's hereditary optic atrophy is primarily due to an inherited temporary disease of the pituitary body."

AMAUROTIC FAMILY IDIOCY (TAY SACHS DISEASE).

The credit for the recognition of this disease is shared conjointly by Waren Tay [3] and Sachs.[4]

The condition is limited to the children of Jewish parents and is invariably fatal.

The slight histological changes in the nerve fibres, combined with the very characteristic changes in the nerve cells, are so unlike the morbid anatomy of any other condition that it seems clear that Amaurotic Family Idiocy is a disease *sui generis*.

A marked familial tendency is often manifested, as in a family reported by Kingdon and Risien Russell [5] in which four out of seven children were affected. The sexes are about equally involved.

The clinical progress of the disease may be conveniently divided into three stages (Kingdon and Russell).

First Stage.—The children are normal at birth, the first symptoms being noticed at about three months of age. There is weakness of the muscles of the neck and back, and the child begins to lose its sight. Around the yellow spot a greyish-white area is seen which is about twice the size of the optic disc, and at its centre is a small dark red area. These appearances remain unchanged from the time of their appearance till death;

[1] *Archiv. of Ophth.*, 1918, xlvii., 627.
[2] *Trans. Amer. Ophth. Soc.*, 1912—14, xiii., 162.
[3] *Trans. Oph. Soc. U.K.*, 1881, i., 55; 1884, iv., 158; and 1892, xii., 125.
[4] *Jour. of Nerv. and Mental Dis.*, New York, 1887, xiv., 544; 1892, xvii., 603; *New York Med. Jour.*, 1896, lxiii., 697.
[5] *Trans. Roy. Med. Chir. Soc. of London*, 1897, lxxx., 87.

they are not present at birth. Atrophy of the optic nerve follows till complete blindness ensues.

During the **Second Stage** the infant is unable to sit up owing to the increasing muscular weakness, and becomes apathetic.

Third Stage.—Finally, atrophy of the muscles, exaggeration of the deep reflexes, rigidy of the extremities, and retraction of the head are developed. There is increasing emaciation, and convulsions may occur. Life is rarely prolonged beyond two years. The hearing is unaffected.

The morbid anatomy of this disease has been thoroughly

Fig 72.—The ventral horn cells from a case of amaurotic family idiocy. The nuclei are excentric and are surrounded by the only stainable substance which persisted. Vacuoles are present in many of the cells. All the cells seemed very poor in dendrites, and the origin of the axis cylinders could hardly be recognised. (Poynton, Parsons, and Gordon Holmes.)

investigated by a number of workers, and it has been shown that the essential primary changes are limited to the ganglion cells throughout the body, not only in the retina and central nervous system, but also in the sympathetic ganglia.

It was demonstrated by Poynton, Parsons and Holmes [1] that there may be marked disease of ganglion cells, whilst the corresponding nerve fibres are apparently unaffected, and that the interfibrillary protoplasm of the nerve cells seems to be more affected than the neurofibrils; that, indeed, these latter

[1] *Brain*, 1906, xxix., 180.

are only afterwards destroyed, as a consequence of the disease of the inter-fibrillary protoplasm (Fig. 72).

As the cells become destroyed, a marked secondary neuroglial proliferation takes place, and it is as a consequence of this increase that the brain, as pointed out by Mott and Carlyll [1] is increased rather than diminished in bulk.

The retinal changes have attracted the special attention of Verhoeff,[2] Hancock and Coats,[3] Poynton, Parsons, and Holmes,[4] and Cohen and Dixon, all of whom have taken particular care

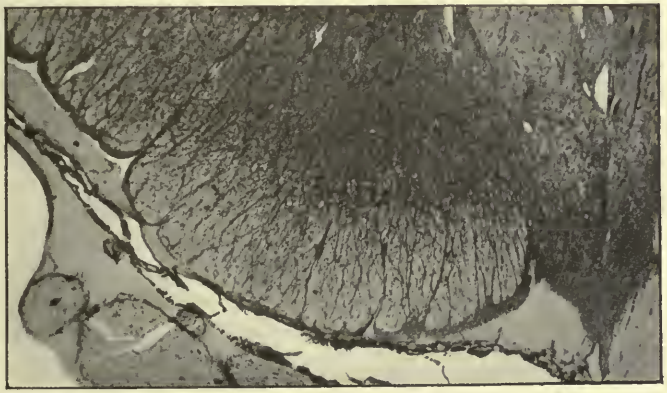


Fig. 73.—A section through a part of the spinal cord treated by Weigert's stain to show the increase of the neuroglia. The sclerosis of the pyramidal tract as shown by the darker tinting, contrasts with the pallor of the neighbouring spino-cerebellar tracts. (Poynton, Parsons, and Gordon Holmes.)

to remove and fix the eyes within a very short time of death. These observers are agreed in every essential concerning the changes present. These changes are absolutely confined to the ganglion cells and their processes, and consist in the entire absence of normal Nissl granules and destruction of the normal cell processes (Fig. 72). Thus Verhoeff says: "With the exception of the ganglion cells the retina is absolutely normal, not a single

[1] *Proc. Roy. Soc. Med.*, 1911, iv., Path. Sect., 147, and *Archiv. of Neurology*, 1907, iii., 218.
[2] *Archiv. of Oph.*, 1909, xxxviii., 107.
[3] *Brain*, 1911, xxxiii., 514.
[4] *Brain*, 1906, xxix., 180.

normal ganglion cell is anywhere to be seen"; and Coats "Not a single cell is to be found in which they (the Nissl granules) are normal." The nuclei are shrunken, there is no retinal œdema (Verhoeff).

Mott showed that these changes were present in the brain, cerebro-spinal ganglion cells, and also in the sympathetic system; Sachs showed they were present in the pyramidal cells of the cortex.

With regard to the changes which produce a cherry-red spot at the macula surrounded by an area of milky haze, Coats says it is clear in this disease that changes in the protoplasm of the ganglion cells is capable of producing this appearance. He uses this observation to support Elschnig's contention, that the similar ophthalmoscopic appearances seen in cases of embolism of the central retinal artery are not due to retinal œdema, but are due to coagulation necrosis of the ganglion cells from cutting off of their blood supply; there is, however, this very marked difference between the two conditions, that in the one the appearances persist till death, whereas in the case of embolism of the retinal artery they completely disappear within about a fortnight.

CONGENITAL WORD BLINDNESS.

The first cases of this condition published in English literature were by Hinshelwood [1] who later incorporated what was known of the condition in his book on the subject.

In congenital word blindness there is great difficulty in reading the written word, so that reading and spelling are exceedingly irksome or impossible, whilst other objects are recognised quite well. The auditory memory for words and numbers is unaffected, numerals give rise to much less trouble and the children are often good at arithmetic. The subjects of the condition are quite bright and intelligent, often exhibiting a marked mechanical bent.

So soon as they go to school it is noticed that they do not learn to read or copy, and have difficulty with the alphabet,

[1] *Lancet*, 1900, i., 1506; *Brit. Med. J.*, 1904, ii., 1303; *Oph. Review*, 1902, xxi., 91.

and, in consequence, they are apt to be blamed for unwillingness or stupidity, although in other respects they are bright and equal to the other children. They never read books for pleasure.

Any degree of the defect may occur, from a condition in which there is more than the usual difficulty experienced in earning to read, to cases in which it is impossible to do so.

Hinshelwood says of one of his cases that while he could recognise a few letters of the alphabet, he had almost no visual memory. Nettleship [1] says of a case : " He receives information with ease if conveyed orally, reading is exceedingly difficult to him, yet he can pronounce words spelt out to him. Immense pains have been taken in trying to teach him to read."

Some children, after much labour and great care expended on them, have overcome their defect to a very marked extent. Thus Nettleship says of one of his cases : " After an enormous amount of patience and perseverance this boy learned to read easily, and he now reads both to himself and aloud with facility and pleasure : he is now a lawyer."

With others the defect remains a serious handicap throughout life.

Fisher [2] suggests that there are two groups of cases. In the one there is a congenital failure of development of the visual memory centre in the left angular and supra-marginal gyrus, and in the second group this same centre is damaged during birth by a limited meningeal hæmorrhage, and so corresponds with the spastic palsies of children. Bastian ascribes it to a commissural defect.

Incidence and Frequency.—A number of these children are brought to hospital because it is assumed that they cannot *see* to read ; examination, however, fails to reveal any abnormality in the eyes, and in the rush of hospital work some, no doubt, fail to get recognised.

Thomas [3] calculates that one in 1,000 children in elementary schools suffer from the condition.

It is of much greater frequency in boys than in girls. Thus,

[1] *Ophth. Review*, 1901, xx., 61.
[2] *Trans. Ophth. Soc. U.K.*, 1910, xxx., 216.
[3] *Public Health*, May, 1908, xxi., 90.

in 100 cases collected by Thomas in the London County Council special schools seventy-six were boys. He estimates that it is five or six times more common in boys than in girls, and other authors are in general agreement with these figures.

NIGHT BLINDNESS.

The facility with which normal individuals see in dim illumination varies within rather wide limits, and those with myopia of any considerable degree are usually especially defective in this respect.

There are, however, several sharply defined groups of cases in which patients are unable to see so soon as it becomes dusk; some are due to acquired disease, some are hereditary and congenital, with or without discoverable disease of the eye.

Congenital Night Blindness.—This is a condition in which inability to see at night is the only symptom. The fundi are normal, the visual fields are complete, the visual acuity by day is unaffected; it is unassociated with any physical defect, is stationary, and does not lead to blindness, and both sexes are about equally affected.

During the war many men whose lives had been spent in and around towns and cities, where real darkness is seldom, if ever, experienced, found that at night they had to be led by their companions over duck boards or shell-broken ground, and thus were first made aware of their comparative, though perhaps, slight defect.

Nettleship has traced this condition through nine generations[1]; he gives a genealogical tree commencing in the year 1637, comprising 2,121 individuals, and of these, seventy-two males and sixty-two females are known to have suffered from night blindness. Other cases are reported by Nettleship,[2] Leber,[3] and Sinclair.[4]

Night blindness is a prominent feature of two hereditary diseases of the retina, retinitis pigmentosa and retinitis punctata

[1] *Trans. Ophth. Soc. U.K.*, 1907, xxvii., 269.
[2] *Roy. Lond. Ophth. Hosp. Reports*, 1887, xi., 68.
[3] *Graefe und Saemisch Handbuch*, 1877, v., 648.
[4] *Ophth. Review*, 1905, xxiv., 255.

albescens. In each of these conditions there are very characteristic retinal changes, usually associated with changes in the lens, vitreous, and choroid; the visual defect is severe and progressive, and virtual blindness ultimately ensues.

Acquired Nyctalopia.—In extensive diffuse inflammatory disease of the retina and choroid, *e.g.*, syphilitic chorio-retinitis, nyctalopia is usually present.

Nyctalopia associated with Xerosis of the Conjunctiva.—There is a form of temporary acquired night blindness which is associated with the presence of small xerotic patches on the conjunctiva. These patches are triangular in shape with their base adjacent to the corneal margin, and are limited to that part of the conjunctiva which is exposed when the eyes are open.

In some cases the general nutrition is defective; thus Schiele [1] points out its prevalence in Kursk after the Lenten fasts. In other cases the subjects appear to be in perfect health.

Hepburn [2] states that it is most frequent in the summer months, and that 90 per cent. of his patients were males; he says that if the xerosis patches disappear, so also does the visual defect.

Ishihara [3] found the fat contents of the blood deficient and so indicated the line of treatment; he states that oil obtained from the flesh of eels is a popular remedy in Japan, and is especially beneficent.

Treitel [4] has shown that if the patient is kept in the dark, the night blindness is recovered from in the course of a day or two.

BLUE SCLEROTICS.

Under this somewhat misleading title an interesting form of hereditary disease has been described, in which the sclerotic coat of the eye is so thin, that the underlying pigmented coat shows through and produces a deep blue colour; in addition, in a considerable proportion of cases, the bones are fragile,

[1] *Wochenschr. für Therapie und Hygiene des Auges*, 1904, 32.
[2] *Trans. Ophth. Soc. U.K.*, 1910, xxx., 167.
[3] *Klin. Monats. f. Aug.*, 1913, xv., 596.
[4] von Graefe's *Archiv. f. Opath.*, 1885, xxxi., 139.

and the ligamentous structures about the joints so weak, that fractures and sprains occur from very slight violence.

The incidence is about equal in the two sexes and the transmission is always direct; thus, in a family of whom some are affected, the children of those with white sclerotics are never affected, whilst those with blue sclerotics may or may not transmit the disease.[1]

It has been shown[2] that those affected are usually of small stature as compared with the unaffected members of the family.

The fractures mend without trouble, are not associated with malignant disease, and the condition does not appear to shorten life. Several extensive pedigrees have been reported, but it is notable that in some there is no mention of fragility of the bones.

Burrows published one composed of twenty-nine individuals, of whom thirteen had blue sclerotics, and of these nine suffered from brittle bones, multiple fractures occurring in seven of them; whilst of fourteen with white sclerotics of whom he had reliable information, not a single one was known to have sustained a fracture.

Conlon's[3] similar group extended to five generations.

Stephenson[4] published a pedigree of twenty-one individuals, which was apparently afterwards extended by Harman[5] to five generations and fifty-five individuals; of these, thirty-one had blue sclerotics, but in none of these is any mention made of fractures; in several cases the presence of embryontoxon at the corneal margin is mentioned.

The association of the two conditions appears first to have been recognised by Eddowes[6] in a boy whom he treated for nine independent fractures in the course of two years. He says: "This child had the darkest sclerotics which I ever remember to have seen." He speaks of another patient, a girl, who had

[1] Burrows, *Brit. Med. Jour.*, 1911, ii., 16.
[2] Cockayne, *Ophthalmoscope*, 1914, xii. 217, and *Proc. Roy. Soc. Med.*, 1914, vii., part i., Sect. Dis. of Child., 101; Harman, "Ophthalmoscope," 1910, viii., 560.
[3] *Boston Med. and Surg. J.*, 1913, clxix., 16.
[4] *Ophthalmoscope*, 1910, viii., 330.
[5] *Ophthalmoscope*, 1910, viii., 559.
[6] *Brit. Med. Jour.*, 1900, ii., 222.

sustained several fractures, on one occasion by falling on a bed; her father had broken his arm whilst putting his coat on.

Adam [1] reports a case in which ten fractures had occurred.

Pathology.—It seems that in these individuals there is a defect, not only in the fibrous coat of the eye, but frequently also in this constituent of the bones and of the ligaments and capsules of the joints. Eddowes says: "I would suggest that the transparency of the sclerotics indicates a want of quality or quantity of the fibrous tissue forming the framework of the various organs of the body, and probably explains the want of spring or toughness in the bones of these peculiar individuals."

Buchanan [2] was fortunate enough to obtain an eye for examination which had been seriously damaged as the result of an accident. The sclerotic was bright blue in colour; there is no mention of fractures. The sclerotic was about one-third of the normal thickness, the cornea, too, was much thinner than usual, and its anterior elastic lamina was entirely absent. The fibres of the sclerotic are described as being of normal thickness but very deficient in numbers, the blue colour was due to the pigment layer showing through the very thin sclera, and corresponded with the blueness of a staphyloma in this region.

Cockayne states that in his patient of one year and ten months old, the compact bone of the shaft was normal to X-ray examination, but that towards the extremities the bone seemed to be more transparent than is normal at this age: the epiphyses showed no signs of rickets.

OCULAR TORTICOLLIS.

This term was applied by Cuignet in 1874 to a compensatory tilting of the head, in cases of paralysis of one of the muscles which control the vertical movements of the eyes, and is unconsciously assumed to avoid diplopia.

It is in all ways comparable to the habit of turning the head to one side, which is usually assumed by patients with a paralysed external rectus muscle, the head being turned towards

[1] *Berlin Ophth. Gesells.*, 1913.
[2] *Trans. Ophth. Soc. U.K.*, 1903, xxiii., 267.

the side of the muscle which is paralysed or paretic, in order to obviate double vision.

In almost all the cases reported, the defect of movement has arisen quite early in life and is usually of congenital origin; the position, however, has been assumed in a few acquired cases, where the vertical movements have been disturbed as a result of operative interference, usually in connection with the frontal sinus.

It is probable that in a case of complete uncomplicated paralysis of the requisite muscles, an occurrence of great

FIG. 74.—A case of "ocular torticollis" showing the head held in the compensated position, and the vertical deviation of the eyes when the head is held erect. (Stephenson.)

rarity, the position of the head would have to be so exaggerated in order to compensate for it that it would not be adopted.

The condition has to be distinguished from torticollis due to contraction of the sterno-cleido-mastoid, for which it has been mistaken, and for which ineffective operative procedures have been undertaken.[1] The differentiation is not difficult if the possibility is borne in mind. The sterno-mastoid is not contracted and does not stand out as a tight band under the skin; the position of the head is a pure tilting to one side—at an angle of 30 degrees from the vertical in Stephenson's case; the chin is not rotated towards the opposite shoulder, as is seen in

[1] Van der Brugh, *Ned. Tijds. v. Geneesk.*, 1905, ii., 365 and 606.

contracture cases; the head is easily bent over towards the opposite side and held there by the patient without effort or confusion if one eye be kept closed; hemiatrophy of the face, which is present and may be very marked in true torticollis, is, at most, slight in ocular torticollis;[1] in Cockayne's case[2] the asymmetry, however, is said to have been marked.

In the assumed position in the ocular cases no squint is visible, and diplopia is not complained of; if, however, the position of the head be corrected, a vertical squint at once appears and double vision is developed.

The condition is usually rectified by a shortening or advancement of the muscle which is defective.

Cases are reported by Dallwig,[3] Landolt,[4] Wadsworth,[5] Risely,[6] Nieden,[7] de Lapersonne,[8] and others.

JAW BLINKING.

This term is applied to a curious phenomenon first described by Gunn,[9] in which a unilateral congenital ptosis is associated with an ability to raise the upper lid only when the mouth is simultaneously opened.

The recorded cases are almost all in infants or children, and the left side is more frequently involved, in the proportion of 18 to 7 (Sinclair).[10]

As a rule ptosis is present, though this is not invariably so. Sinclair found it in twenty-seven out of thirty-two reported cases. The ptosis may be partial or complete, and there is no voluntary power of lifting the lid except to a small extent by the frontalis. On opening the mouth the lid is raised, and on throwing the jaw towards the opposite side by means of the action of the external pterygoid a further upward movement is produced.

[1] Stephenson. *Ophthalmoscope*, 1913, xi., 113.
[2] *Pro. Roy. Soc. Med.*, 1914, vii., part i., Sec. for Dis. of Child., 99.
[3] *Archiv. of Ophth.*, 1901, xxx., 645.
[4] *Bull. méd.*, 1890, 573.
[5] *Trans. Amer. Ophth. Soc.*, 1889, v., 281.
[6] *Trans. Amer. Ophth. Soc.*, 1889, v., 284.
[7] *Centralb. f. prakt. Augen.*, 1892, xvi., 321.
[8] *Archiv. d'ophtal.*, 1905, xxv., 585.
[9] *Trans. Ophth. Soc. U.K.*, 1883, iii., 283.
[10] *Oph. Review*, 1895, xiv., 312.

A number of cases are reported in which the phenomenon was conspicuous in infants when suckling, each movement of suckling being accompanied by a synchronous movement in the drooped eyelid.

Harman [1] has drawn an interesting parallel with the associated movements of opening the mouth and dilatation of the spiracle in fishes. According to him the musculature of the spiracle is twofold: a deep part, corresponding with the external pterygoid in man, opening the mouth, and a superficial part for altering the size of the orifice of the spiracle, with which part the facial muscles of man correspond. Contraction of the deeper muscles which open the jaw (external pterygoid) is associated with relaxation of the superficial muscles which guard the orifice of the spiracle (orbicularis palpebrarum).

How often one sees a patient, when suffering from photophobia from any cause, open the mouth widely in a futile attempt to open the eyes!

CYCLIC CONTRACTION AND DILATATION OF THE PUPIL ASSOCIATED WITH THIRD NERVE PARESIS.

Cases are occasionally seen in which a persisting contraction and dilatation of one pupil having a regular cycle, is associated with a congenital or early acquired paralysis or paresis of the third nerve.

The pupil contracts to about 2 mm., and so remains for from five to ten seconds; it then dilates more slowly to a diameter of 6 or 7 mm.; and again, after some fifteen or twenty seconds, a more rapid contraction sets in, and this regular cycle is a permanent phenomenon.

There is an intimate relationship between the constriction of the pupil and contraction of the internal rectus and between dilatation and contraction of the external rectus, for if either of these muscles is put into action the corresponding action of the pupil is hastened; in some cases there is a similar relation between contraction of the levator palpebræ and the pupil.

[1] *Trans. Ophth. Soc. U.K.*, 1903, xxiii., 370.

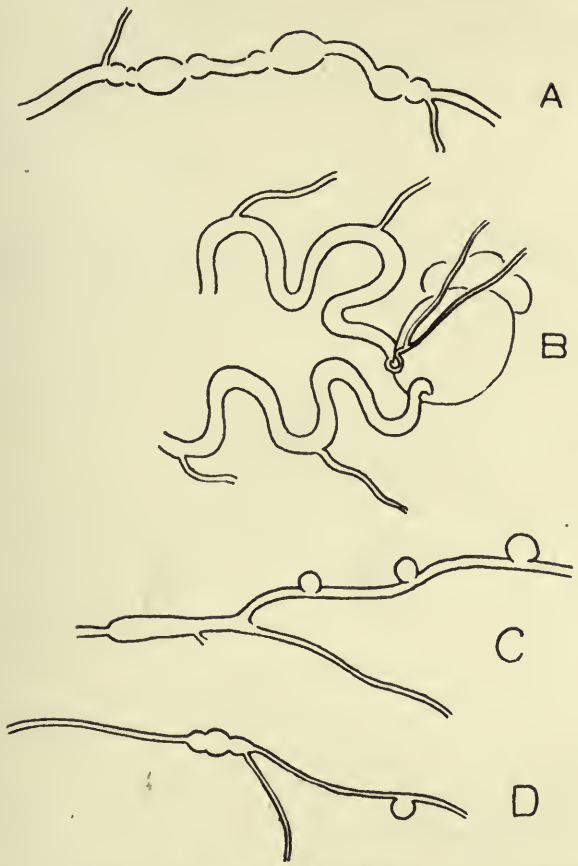


FIG. 75.—Different types of aneurysmal dilatation of the retinal vessels. *A.* Fusiform dilatations in the course of an artery: extensive opaque nerve fibres were also present. (Pringle, *Brit. Jour. of Ophth.*, vol. i., No. 2, p. 88.) *B.* An arterio-venous communication. Note that whilst the main artery and vein are greatly enlarged their collateral branches are of normal size. Five such communications were present in the patient's two eyes. (Foster Moore, *Trans. Ophth. Soc.*, vol. xxxii., p. 77.) *C.* Sacculated aneurysm of an artery. *D.* Sacculated aneurysm of a vein. The two last are from the same patient, and underwent changes whilst under observation. (Story and Benson, *Trans. Ophth. Soc.*, vol. iii., p. 108.)

During contraction the pupil is immobile to light stimulus, but is active to this stimulus both directly and consensually during dilatation.[1]

[1] Coats, *Trans. Ophth. Soc. U.K.*, 1914, xxxiv. 262.

The pupil movements are accompanied by corresponding spasm and relaxation of the ciliary muscle.[1]

Other cases are those of Greeves [2] and v. Hippel.[3]

ABNORMALITIES OF THE RETINAL VESSELS.

The retinal vessels, of course, show varying degrees of tortuosity, but at times such tortuosity is so striking as to evoke comment, even though the condition must be considered to be physiological. Such degree is seen most often in hypermetropic eyes, and involves the veins much more frequently than the arteries,[4] but in some cases both arteries and veins are concerned, as in Benson's case.[5]

Aneurysmal dilatations are at times seen on arteries, veins, and capillaries.

Aneurysms of the large arteries and veins of the retina are quite unrelated as to their ætiology to aneurysms of the large arteries of the body.

When they occur evidence of some other disease of the retina or choroid is seldom if ever absent.

They are probably congenital in origin. The aneurysms may be of the sacculated or fusiform variety on either set of vessels, and are always multiple (Fig. 75).

Arterial aneurysms are reported by Fisher,[6] Story and Benson,[7] Pringle,[8] and others; venous aneurysms by Story,[9] and cases of probable direct communication between arteries and veins are published by Gunn,[10] Wood,[11] and Foster Moore.[12]

[1] Franke, *Klin. Monats. f. Augen.*, 1909, viii, 582.
[2] *Pro. Roy. Soc. Med.*, 1912-13, vi., part. iii., Sect. of Ophth., 23.
[3] *Klin. Monat. f. Augen.*, 1914, lii., 99.
[4] Nettleship, *Trans. Ophth. Soc. U.K.*, 1882, ii., 57; Stephen Mackenzie, *Trans. Ophth. Soc. U.K.*, 1883, iii., p. 100, and 1884, iv., 152.
[5] *Trans. Ophth. Soc. U.K.*, 1882, ii., 55.
[6] *Trans. Ophth. Soc. U.K.*, 1903, xxiii., 73.
[7] *Trans. Ophth. Soc. U.K.*, 1883, iii., 108.
[8] *Brit. Jour. of Ophth.*, 1917, i., 89.
[9] *Trans. Ophth. Soc. U.K.*, 1883, iii., 108.
[10] *Trans. Ophth. Soc. U.K.*, 1884, iv., 156.
[11] *Trans. Ophth. Soc. U.K.*, 1909, xxix., 115.
[12] *Trans. Ophth. Soc. U.K.*, 1912, xxxii., 78.

MEDULLATED NERVE FIBRES.

The importance of medullated nerve fibres in the retina lies in the ophthalmoscopic recognition of them; in addition, however, they have a few points of interest.

It need hardly be remarked, seeing that the nerve fibre layer

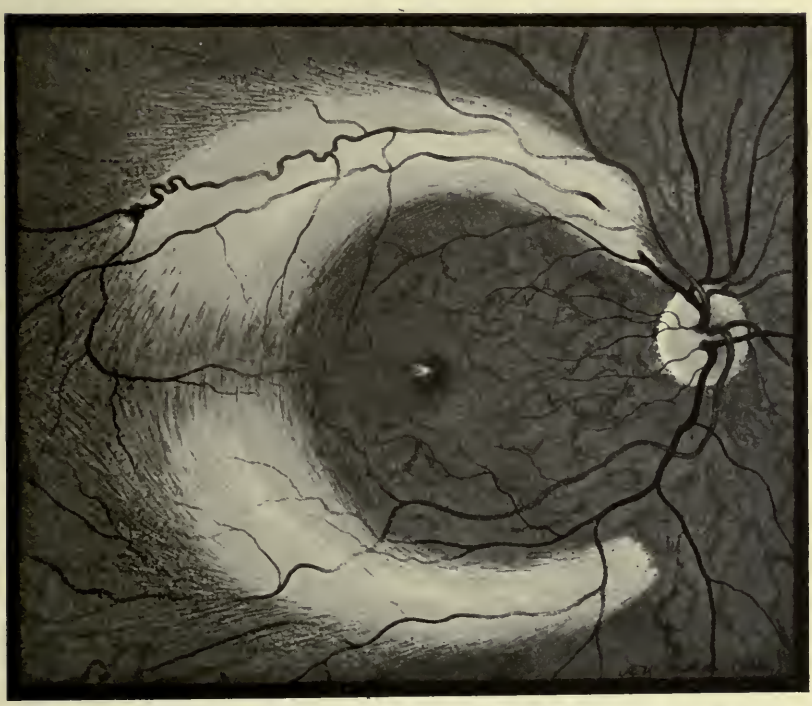


FIG. 76.—An unusual case of opaque nerve fibres which shows up the normal course of the nerve fibres in the affected part of the retina, and the formation of the horizontal raphe. Scotomata were present in the visual field corresponding with the patches. (B. T. Lang, *Trans. Ophth. Soc. U.K.*, 1920, xl., 178.)

of the retina overlies the rod and cone layer, that if the fibres of the former layer were medullated, the vision would be very imperfect, and it has been shown by B. T. Lang [1] that an area of relative scotoma can be mapped out corresponding with a patch of medullated fibres.

[1] *Trans. Ophth. Soc. U.K.*, 1920, xl., 178.

The patches are not present at birth, for Flechsig has shown that different tracts of nerve fibres attain their medullary sheaths at different dates, and normally the optic nerve fibres attain their sheath after birth.

It seems that the development of this sheath is correlated with the attainment of full function, for it has been shown that if in a new-born animal one eye be kept entirely protected from light, the optic nerve fibres on this side become myelinated at a later date than in the eye which has been allowed to function,

FIG. 77.—A section through the optic disc showing a patch of myelinated nerve fibres.

and, conversely, the process of myelination of all the nerve tracts is said to be hurried on in prematurely born children.

In cases of optic atrophy patches of opaque nerve fibres have been seen to disappear.[1]

Ophthalmoscopic Appearances.—The fibres appear as opaque white patches having an obvious striate texture; they are usually immediately adjacent to the disc edge, and extend a short distance outward from it.

Since the retinal vessels lie in the nerve fibre layer, they are in places obscured by the fibres. In a few cases patches occur, isolated in the retina at some distance from the disc, usually along one or other of the temporal vessels (Fig. 76).

In the normal condition, if the fibres are traced from their course in the optic nerve into the retina, they lose their myelin

[1] Wagenmann, v. Graefe's *Archiv. f. Ophth.*, 1894, xl., iv., 256.

sheaths just before their passage through the lamina cribosa, and contrary to what might be expected, this same condition in the main holds good where a medullary sheath is reattained in the retina.

It has, however, been shown by Usher [1] that in this case a very few fibres have a continuous medullary sheath through the lamina cribrosa into the patch in the retina (Fig. 77).

[1] Usher, *Ophth. Review*, 1896, xv., 2; Mayerweg, *Archiv. f. Augen.*, 1903, xlvi, 122.

CHAPTER VII

Oxycephaly—Leontiasis ossea—Migraine—Recurrent intra-ocular hæmorrhage (Eales' disease)—Herpes ophthalmicus—Mikulicz's syndrome—Lactation—Mongolian idiocy—Acute amaurosis of infants.

OXYCEPHALY.

The essential features of this condition are a characteristic deformity of the skull, associated in most cases with exophthalmos and some degree of optic atrophy causing impairment of sight.

The skull is increased in height, the forehead sloping gradually upwards to the vertex which appears pointed, and, as a consequence, the ears seem to be placed too low on the head. Premature synostosis of some of the cranial sutures, especially the sagittal and coronal, seems always to be present, and is probably the cause of the cranial deformity.

Careful measurements of the skulls in a series of cases have been made by Patry.[1]

Of all the forms of cranial distortion this is the variety which is most often associated with optic atrophy.

The cause is quite unknown, but in a few cases a familial and hereditary tendency has shown itself. All investigators are agreed that males are much more commonly affected than females, thus Brav [2] found that of eighty-five cases in the literature seventy were males. The intelligence is not affected, and it does not appear that life is curtailed.

If the skull be examined by X-rays, the bones of the vault more especially, show certain markings or depressions, which give rise to a coarsely-dimpled appearance, to which the term "digital markings" has been applied (Fig. 78). The sella turcica stands out with unusual clearness and appears to be considerably enlarged and displaced backwards.[3]

[1] *Recueil d'Ophtal.*, 1906, xxviii., 158; *Annales d'Oculist.*, 1906, cxxxv., 314.
[2] *Annals of Ophth.*, 1912, xxi., 6.
[3] Morley Fletcher, *Quarterly Journal of Med.*, 1911, iv., 385.

Fig. 78.—A mild case of oxycephaly in which no symptoms were present. The patient, a woman of thirty, sought advice for defective vision, which was found to be due to lamellar cataracts. There was no evidence of optic atrophy, and although the eyes were perhaps a little prominent they would not of themselves have evoked comment. Note the shape of the skull and the digital markings.

Eye Symptoms.—These are the most important of the disease.

Exophthalmos is present in a majority of cases, Beaumont estimates it as 50 per cent.;[1] it may be extreme in degree, and is due to the conformation of the orbits. The depth of the orbits is much reduced, the outer wall formed by the greater wing of the sphenoid appears to be pushed forward, the orbital axes being directed very obliquely downwards and outwards, a condition which is also responsible for the divergence of the eyes which is so usually present. There is rarely any impairment of mobility of the eyes; nystagmus is often present.

Optic Atrophy.—There is no doubt that optic atrophy is an exceedingly common complication of the condition, and especially is this true of the cases put on record. It has, however, to be borne in mind that few patients in whom this symptom was absent would seek advice at all (Fig. 78).

In by far the greatest number of cases the atrophy is due to antecedent papillœdema. Thus Enslin[2] found thirty-six cases of post-neuritic atrophy amongst forty-two cases of atrophy, and Uhthoff[3] estimates primary atrophy at 10 per cent. It seems clear that the papillœdema which is immediately responsible for the atrophy, occurs in early life—Morley Fletcher and Patry believe before the age of five, Uhthoff believes before seven. The atrophy seldom leads to complete blindness, but after a certain stage is reached it makes no further advance, and the vision then remaining is retained throughout life; it is often better than would have been anticipated from the ophthalmoscopic appearance of the optic disc. Some patients are left with good useful vision; thus, Nettleship[4] records the case of a man whom he had seen eighteen years before. He says of him: "He is intelligent, earns a fairly good living as a painter, and that there is no further deterioration of vision since he was last seen," *i.e.*, eighteen years earlier. Morley Fletcher

[1] *Trans. Oph. Soc. U.K.*, 1910, xxx., 44.
[2] von Graefe's *Archiv. f. Ophth.*, 1904, lviii., 151.
[3] *Trans. Ophth. Soc. U.K.*, 1914, xxxiv., exiii.
[4] *Trans. Oph. Soc. U.K.*, 1905, xxv., 383.

says : " In adults the ability to read is rare, though few patients become actually blind." Uhthoff estimates that 7 per cent. become totally blind.

Pathogenesis of the Optic Atrophy.—There is no satisfactory evidence that any narrowing of the optic foramen is developed.

Friedenwald [1] thinks the papillœdema and atrophy are the result of direct pressure exerted by the growing brain, owing to synostosis of the sutures of the vault, comparable to that of a cerebral tumour, a view in which Morley Fletcher concurs.

Uhthoff says : " I am convinced that the increased intra-cranial pressure, with its destructive effects upon the optic nerve and the visual functions, is due to the disproportionate size, and consequent pressure, exercised by the growing brain against the non-yielding cranium."

Patry [2] has reported cases in which instead of the horizontal axis of the cornea being greater than the vertical axis as is normal, the reverse has been the case.

LEONTIASIS OSSEA.

This disease is characterised by an overgrowth of the bones of the face and skull, which occurs sometimes in a diffuse manner, but more often in the form of localised bosses ; its progress shows no tendency to be limited by the sutures. It commences in early life and is slowly progressive. Great distortion of the physiognomy results. The cause is unknown.

As the hyperostosis progresses it encroaches on surrounding structures, such as the cranial, nasal and orbital cavities, and the antrum of Highmore and frontal sinus, sometimes to the complete occlusion of the last two, and gives rise to symptoms corresponding with the parts involved. The chief ocular manifestations consist of epiphora from obstruction of the nasal ducts, displacement of the eyes, most often forward and outward, papillœdema where the cranial cavity is encroached upon causing an increase of intra-cranial pressure, and optic atrophy.

[1] *Amer. Jour. Med. Sci.*, 1893, cv., 529.
[2] *Annales d'Oculist.*, 1906, cxxxv., 314.

Sattler [1] reports the case of a girl in whom the first symptoms were noticed at the age of eleven, and who died from a hæmorrhage at the base of the brain at the age of twenty-one. Besides other changes, one frontal sinus was completely occluded, and the sphenoidal sinus was much contracted. Two years before she died optic atrophy developed, first in one eye and then in the other, but post-mortem examination failed to reveal any encroachment upon the optic foramina which might account for this.

For a complete account of the disease a monograph by John Green, jun.,[2] should be consulted.

MIGRAINE AND ASSOCIATED COMPLICATIONS.

In migraine attacks visual phenomena form one of the most constant and striking features; they usually precede the headache and may take most varied forms. Thus bright irregular zig-zag lines may be seen, the edges of which are sometimes brightly coloured, the so-called fortification spectra; at other times various defects in the visual fields are developed; there may be hemianopia affecting the lateral fields, or the upper or lower parts of objects may be obscured, or less defined field defects may occur—a general contraction of them is not rare, and sometimes a central scotoma is complained of; there may be scintillating lines or flashes or sparks, or whirling objects, coloured or otherwise, or a more general and confused blurring may be present.[3] Photophobia is often prominent (Fig. 79).

In a condition in which visual phenomena are so prominent a symptom, it is natural that critical attention should be directed to the ocular mechanism, and whilst nothing but good will come of the correction of any real error of refraction that may exist, there is, I believe, no direct causal relationship between any ocular abnormality, refractive or otherwise, and migraine.

The fundi are normal during an attack.

[1] *Trans. Amer. Ophth. Soc.*, 1900-3, ix., 59.
[2] *Amer. J. of Ophth.*, 1915, xxxii., 293.
[3] Liveing, "Megrim and Sick Headache," Churchill, 1873.

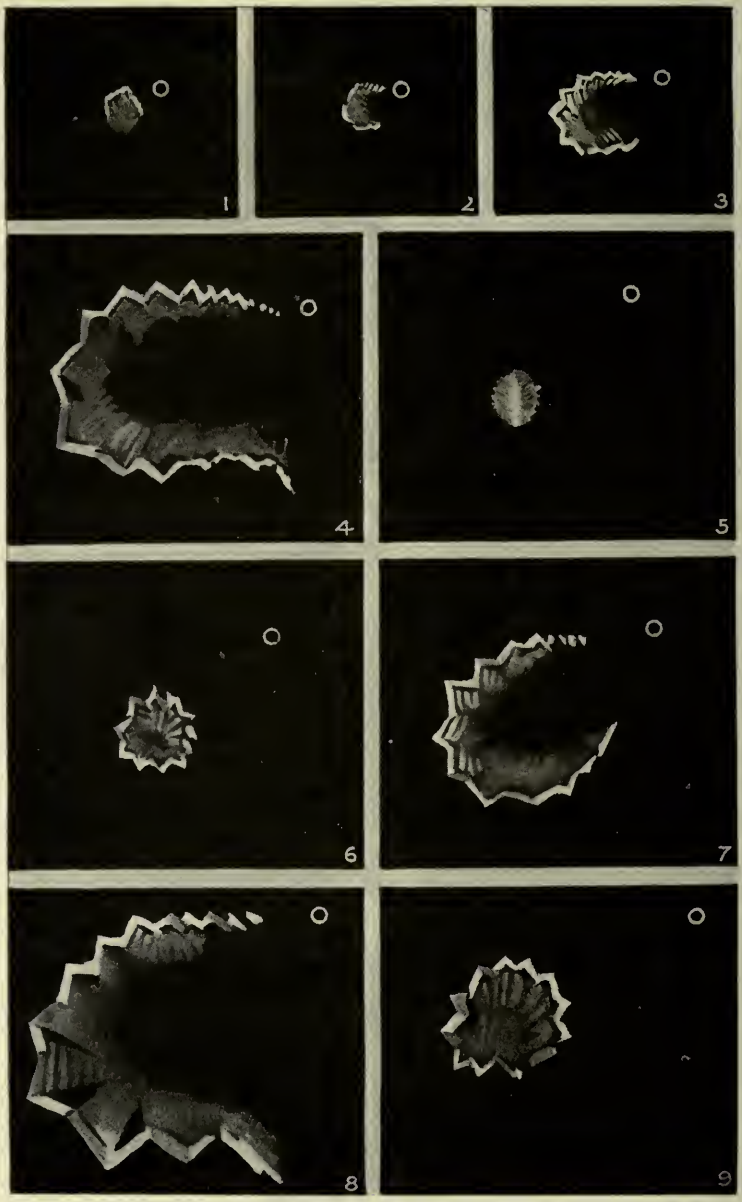


Fig. 79.—Nos. 1 to 4 represent the gradual evolution of the fortification spectrum of migraine as seen in the dark commencing quite close to the fixation point. Nos. 5 to 8 represent a similar phenomenon commencing some distance from the fixation point. No. 9 represents a fresh attack beginning whilst No. 8 was still at its maximum; such secondary attacks never develop fully unless they occur in the other half of the visual field. The small circle in each figure represents the fixation point. The bastioned outline is often brightly coloured, and the whole figure has a "boiling and trembling" motion. From Dr. Airey's paper, *Phil. Transac.*, 1870, 247.)

Some individuals have attacks which are evidently of the nature of migraine, in which the phenomena are entirely limited to the subjective visual manifestations, a headache only occasionally following.

It has often been supposed that migraine has affinities with epilepsy; it is, however, very unusual to elicit a history of epilepsy in those affected, and Hubbell [1] states that of 1,500 patients with ophthalmic migraine none had epilepsy. Wilfred Harris,[2] in speaking of the hemianopia which accompanies migraine, says that in many cases an epileptiform discharge may originate in or near the half vision centre on one side, in some cases producing only temporary hemianopia, in others spreading and producing a typical epileptiform fit, and again, in others giving rise to unilateral convulsions without loss of consciousness.

There can, I think, be no doubt that its incidence is higher amongst those of high intellectual attainments than in those of meaner ability.

Lloyd [3] lays stress on migraine as an exciting cause of hysterical manifestations in those predisposed, and attributes some of the unusual symptoms to this association.

Ophthalmoplegic Migraine.—This term was suggested by Charcot [4] for a defined group of cases in which a palsy of some of the ocular nerves, more especially the third, at first temporary, but sometimes becoming permanent later, is associated with migraine.

In most cases migraine without the ocular palsy has already existed for a number of years, and the ophthalmoplegia first makes its appearance after an attack of unusual severity, and thereafter occurs in subsequent attacks. It remains limited to the side on which it first occurs, and is seldom if ever bilateral.

The condition affects the sexes equally, and usually begins in early life.

The attacks occur at greatly varying intervals; sometimes a

[1] *Jour. Amer. Med. Ass.*, 1908, li., 480.
[2] *Brain*, 1897, xx., 307.
[3] Posey and Spiller, "The Eye and the Nervous System," 1906, 709.
[4] *Rec. d'Ophtal.*, 1890, xii., 623.

week only may intervene, and at other times so long as four years or longer.[1] The paralysis outlasts the acute symptoms, and takes from one to seven days to recover. The recovery is usually at first complete, but later a residue remains between the attacks until ultimately a permanent and complete paralysis persists. As a rule the shorter the interval between the attacks the more rapid is the recovery.

The third nerve is the one much most often implicated, and whilst all the external branches are involved, the internal branches often escape.

In a case of Karplus', attacks of sickness with ptosis started at the age of six months, and occurred about every two or three weeks till the age of twenty. After this age, recovery from the paresis between the attacks was incomplete, and an external squint, ptosis, and a dilated and inactive pupil were ultimately developed. The patient died at the age of forty-three (*vide infra*).

Some observers have described groups of cases in which recurrent temporary ocular palsies have been associated with severe headaches, which, however, were not obviously of the migrainous type. Thus Holmes Spicer and Ormerod [2] prefer the title "Recurrent Paralysis of Ocular Nerves," and Fisher,[3] in describing such cases, uses the title "Transient Ophthalmoplegia Externa associated with Attacks of Severe Headaches," for, he says, the term Ophthalmoplegic Migraine tends to detract from a thorough search for some organic lesion which is very likely present in all such cases; and Lloyd says "it is necessary for the present to hold in abeyance any theory which does not include the possibility of an organic lesion." It is undoubtedly the case that a certain number of patients who suffer from severe recurrent headaches do in the course of time develop ophthalmoplegia and so are classified under the title "ophthalmoplegic migraine" though the available post-mortem evidence tends to show that in them an organic lesion is present.

[1] Knapp, *Boston Med. and Surg. Journal*, 1894, cxxxi., 308.
[2] *Trans. Ophth. Soc. U.K.*, 1896, xvi., 277.
[3] *Ophth. Review*, 1907, xxvi., 31.

Thus of four autopsies, Gubler [1] found plastic exudation surrounding the right third nerve: Weiss [2] says "the third nerve showed a tubercular enlargement at the point where it issued from the crus": Thomsen [3] found a fibro-chondroma of the right third nerve, and Karplus [4] found a fibroma the size of a split pea in the course of the third nerve connected with the dura; the tumour was thought to have been congenital, and had caused degeneration of the nerve by pressure.

P. C. Knapp [5] concludes that the recurrent third nerve palsy is due to some vascular change, inflammatory or œdematous, in a focal lesion involving the root of the third nerve, and that as the œdema subsides, the conducting power of the nerve is wholly or partly restored, and the paralysis disappears.

In spite of the foregoing, until satisfactory evidence can be adduced for believing that all such cases are dependent upon an organic lesion, it would seem useful to retain the term "ophthalmoplegic migraine."

Another important concomitant of migraine is hemianopia. This has already been mentioned as a temporary visual phenomenon associated with the attacks, but a number of cases are recorded in which the defect, at first quite temporary, has later become permanent, so that with some reason one might speak of an hemianopic migraine in the same way as the term ophthalmoplegic migraine is used.

According to Harris, temporary hemianopia may last for twenty-four hours or more, and he makes the important observation that in all cases of absolute transient hemianopia, the dividing line between the seeing and blind halves passes through the fixation point.

Cases in which permanent hemianopia has resulted have been published by Thomas [6] (three cases), Gowers [7] (one case),

[1] Quoted by Wadsworth, *Trans. Amer. Ophth. Soc.*, 1885 87, iv., 467.
[2] *Ibid.*
[3] *Ibid.*
[4] *Wiener. klin. Wochensch.*, 1895, viii., 883, 901, 922.
[5] *Boston Med. and Surg. Journal*, 1894, cxxxi., 308.
[6] *Jour. of Nerv. and Ment. Dis.*, 1907, xxxiv., 153.
[7] *Brit. Med. Jour.*, 1909, i., 1403.

Ormond [1] (two cases), Gordon Holmes [2] (one case) and Uhthoff [3] (five cases).

Uhthoff's cases all arose after the migraine had recurred for many years, and in none of them were other lesions present, but in some of the other cases weakness of a limb or limbs did occur.

It is a conspicuous fact that almost all of these cases were in young women several of whom were pregnant.

RECURRENT INTRA-OCULAR HÆMORRHAGE OF UNKNOWN CAUSE IN YOUNG ADULTS.

A group of cases of recurrent intra-ocular hæmorrhage occurring chiefly in young adult males associated with epistaxis and constipation and with no other constitutional disease, was first defined by Eales,[4] and consequently the condition is sometimes known as Eales' disease.

It is evident, however, on looking through the cases reported under this head, that they do not form a homogenous group, and that cases are included which rightly belong elsewhere. Thus, some cases of Coats' disease are probably included; Hiram Woods [5] attributes some to helminthiasis; Weeks, some to intestinal toxæmia, and some afterwards are merged into the group of retinitis proliferans.

Incidence.—Eales believed the condition was limited to young adult males, but though undoubtedly most frequent in the male sex, a few cases which appear to be of the same character have been reported in women.

In his patients, one eye was chiefly and primarily affected, and whilst in most cases both eyes are affected, they are usually involved in an unequal degree.

Ophthalmoscopic Features.—The characteristic feature is the occurrence of hæmorrhages into the retina which may or may not afterwards invade the vitreous body. The hæmorrhages

[1] *Trans. Oph. Soc. U.K.*, 1913, xxxiii., 138.
[2] *Trans. Oph. Soc. U.K.*, 1913, xxxiii., 145.
[3] *Trans. Oph. Soc. U.K.*, 1914, xxxiv., 226.
[4] *Birmingham Med. Review*, 1880, ix., 262; and *Ophth. Review*, 1882, i., 41.
[5] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 254.

are chiefly towards the periphery, are rather large, and are irregular rather than flame-shaped. In some cases, retinal exudates have in addition been present.[1] The blood may suddenly burst through and infiltrate the vitreous, causing rapid loss of sight and rendering ophthalmoscopic examination impossible.

With the absorption of the blood from the vitreous, which is a slow and tedious process,[2] vision is recovered.

General Constitutional Condition.—It is a feature of these cases that all evidence of any serious constitutional disease that might be expected to give rise to such hæmorrhages, is entirely absent. There is no evidence of disease of the kidneys, heart, or blood vessels. The points upon which Eales laid especial stress were the occurrence of epistaxis, constipation, bradycardia, the pulse rate being habitually below sixty, dyspepsia, headaches, lassitude and want of energy; syphilis is not a cause. According to Wilmer[3] there is commonly a delay in the coagulation time of the blood.

Eales expresses his views as follows :—

"From the absence of any evidence of any of the various blood conditions known to cause hæmorrhage; from the absence of albuminuria, diabetes, gout, syphilis, and of any high arterial tension; from the character of the hæmorrhage, and from the evidence of local variations of circulation and from the slow pulse, constipation, flushing of the face, headache, and puffiness and discoloration of the eyes, I am inclined to attribute this combination of conditions to a neurosis affecting both the circulatory organs and the digestive system, leading on the one hand to partial inhibition of the muscular movements of the bowels, and to a vaso-motor contraction of the vessels of the alimentary canal, with inhibition of its secretory functions, thereby causing dyspepsia, constipation, malnutrition; and on the other hand to a compensatory dilatation of the systemic capillaries, especially those of the head, and in these cases, of the retina, causing over-distension of the venous

[1] Cunningham, *Trans. Ophth. Soc. U.K.*, 1912, xxxii., 177.
[2] Sattler, *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 250.
[3] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 251.

system and systemic capillaries, with liability to rupture on the occurrence of any intensifying cause. Hence the headache, the epistaxis, the retinal hæmorrhages, and the tortuosity and fulness of the retinal vessels, and temporal artery."

Progress.—Recurrence of the hæmorrhages is the rule, their frequency varying much. In some cases the vitreous becomes permanently opaque, " retinitis proliferans " with fibrous tissue development in the retina occurs, the retina becomes detached, and in the course of several years sight is permanently lost. In other cases blindness results from the onset of glaucoma.[1]

But not all cases run so unfavourable a course ; in some, after a varying time, the occurrence of the hæmorrhages becomes less frequent and is finally arrested, the blood is absorbed from the vitreous, and although the transpareney of the latter is not completely restored, good vision returns.

Sattler [2] says useful vision is often recovered after a long and tedious time. Hiram Woods [3] says " the hæmorrhages go on for some time, and then for some reason or another they stop ; why, we cannot say."

In one case [4] the common carotid artery was tied with success, to arrest the hæmorrhages in the right eye, the left having previously been lost as a result of the condition.

I have seen a woman in whom recurrences of the bleeding showed a marked tendency to occur with the menstrual periods, and who had already lost the sight of one eye ; it had, therefore, been thought advisable to remove the ovaries, in the hope that the sight might thus be preserved. The periods ceased, but the retinal hæmorrhages persisted, and total blindness resulted.

HERPES OPHTHALMICUS.

When Herpes Zoster attacks the trigeminal nerve, it is the ophthalmic division that is most often involved, and intra-ocular inflammation is a common complication. The condition is rarely seen in the young, and is more severe in the aged.

[1] Jonathan Hutchinson, *Trans. Ophth. Soc. U.K.*, 1881, i., 26.
[2] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 250.
[3] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 254.
[4] Mayweg, quoted by Davis, *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 248.

It is a striking and interesting fact, that not only is involvement of the second and third division of the fifth nerve exceedingly rare, but the disease often picks out particular branches of the first division, the remaining branches escaping entirely. Thus, the supra-trochlear and nasal branches may escape or may alone be involved.

The eye affection takes the form of a very intractable keratitis with iritis, and is said to occur only in those cases in which the nasal branch of the trigeminal is involved, and further, to vary in severity, according as this branch manifests the disease in a severe or mild form.

Hutchinson [1] says: "It would, I think, be quite safe to assert that the eye scarcely ever suffers much when the nose is not affected, and that the severity of the eruption on the one part is usually in direct relation with the severity of the inflammation of the other." Bowman [2] says: "I have not found affection of the eyeball to occur specially in those cases of ophthalmic zoster in which the eruption followed the course of the nasal branch." Hutchinson, however, from a further experience, reporting forty-one cases in detail [3] says: "All these cases support my former inference, that the nutrition of the eyeball is endangered only when the disease affects the oculo-nasal twig, a circumstance which is made apparent by the appearance of the eruption on the tip of the nose."

Pain and tenderness along the course of the branches of the nerve precede the eruption.

It is a conspicuous fact that the eye does not become inflamed until the eruption is past its acme and is already subsiding, and that the eye remains inflamed and irritable for weeks or months after the skin lesion is soundly healed. The cornea becomes deeply infiltrated in the form of greyish patches, or lines and vascularisation of its structure occurs; occasionally vesicles appear, which on bursting give rise to superficial ulcers; the ulcers never perforate and hypopyon does not arise.

[1] *Royal London Ophth. Hosp. (Moorfields) Reports*, 1866, v., 191; and 1869, vi., 181.
[2] *Roy. Lond. Ophth. Hosp. Reports*, 1869, vi., 181.
[3] *Roy. Lond. Ophth. Hosp. Reports*, 1869, vi., 263.

When recovery is complete, there is usually some permanent residual opacity in the cornea which may greatly spoil the sight.

The iritis is not often severe and there is seldom much exudate.

During the attack the sensation of the cornea is impaired, and this impairment lasts for long after the disease is obsolete, and, indeed, it is probable that the normal sensitiveness is never restored, and from this cause a neuro-paralytic keratitis may afterwards arise. Apart, however, from this, recurrences never occur and both sides are never involved.

It is not rare to find associated paralysis of other cranial nerves, such as the oculo-motor, abducent, and facial, and in the case of the facial nerve the consequent incomplete protection of the cornea, combined with impaired sensation, is especially apt to result in corneal ulceration.

Pathology.—The pathology of herpes zoster, including herpes ophthalmicus, has been worked out with especial care by Head and Campbell.[1] They state that the first satisfactory report upon the post-mortem appearances in herpes zoster was made by Sattler [2] in a case of herpes ophthalmicus. They examined the Gasserian ganglion from a case in which death occurred 190 days after the acute disease; it showed what appeared to be the remains of an old hæmorrhage, with some destruction of nerve cells in that portion corresponding to the first division of the nerve. The changes are similar to those which occur in a posterior spinal root ganglion in the case of herpes zoster of the trunk or limb, and are summarised as follows. If the patient has died with the eruption still out upon the skin, the affected ganglion will be found to be in a condition of profound inflammation, with areas of extravasated blood; or if the patient has died quite early, the blood may be seen with the naked eye. Similar changes are present in that part of the sheath which covers the diseased portion of the ganglion; the vessels are engorged, blood is extravasated, and the sheath is invaded by multitudes

[1] *Brain*, 1900, xxiii., 353.

[2] *Medicin. Jahrb. von der K. K. Gesells. der Aerzte.*, 1875, quoted Head and Campbell.

of small round, deeply staining cells. As soon as the inflammation has expended itself absorption begins, and ultimately the focus becomes converted into fibrous tissue; within this area all ganglion cells and nerve fibres are destroyed and the overlying sheath is thickened.

Head and Campbell comment on the fact, that the implication of a ganglion in some local process, such as malignant disease, can produce an herpetic eruption which is indistinguishable from that which arises as a manifestation of the acute specific disease.

MIKULICZ'S DISEASE OR SYNDROME.

This disease was first described by Mikulicz in 1888, since when many cases have been reported.

The symptom complex consists in a chronic, painless, symmetrical enlargement of certain of the glands of the head, unassociated with any discoverable general systemic disorder. In some cases one or two pairs of glands may alone be affected, in others there may be enlargement of the lachrymal glands, the parotid, submaxillary, and sublingual salivary glands, and even the glands of the hard palate may be included; the lachrymal glands are usually those first involved.

The condition affects the sexes equally, it occurs in the young and the old, and except in so far as lack of secretion may cause a dryness of the conjunctiva or mouth, it does not affect the general health. Ziegler,[1] whose paper should be consulted for an excellent account of the disease and a full bibliography, states his belief that a careful examination of all cases would probably reveal some lesion of the respiratory tract which had not been reported.

Mikulicz states that the enlargement of the glands is entirely due to the enormous small-celled infiltration of the interstitial tissue; he looks upon it as a true lymphoma. Kummel found the salivary glands soft and of marrow-like consistence, white, and poorly vascular. He found the gland densely infiltrated with round cells, and lymphocytes poor in protoplasm.

[1] *Trans. Amer. Ophth. Soc.*, 1910-11, xii., 222.

Thursfield[1] who gives an excellent review of the disease and of the literature, points out that under the head of Mikulicz's disease are included a number of distinct groups in which bilateral swellings of the salivary glands, either with or without an accompanying enlargement of the lymphatic glands, form the most characteristic symptom.

He defines eight clinical groups of which the following are perhaps the most important:—

1. A congenital, hereditary, or family affection.
2. "Mikulicz's disease" proper.
3. "Mikulicz's disease" with involvement of the lymphatic apparatus.

The progress of the disease is very slow; it may last for ten years and relapses are frequent; it does not, however, appear to affect the health by dissemination or otherwise.

PROLONGED LACTATION.

In a few cases loss of sight with slight ophthalmoscopic changes have been attributed to prolonged suckling.

Two cases are reported by Villard,[2] in which papillœdema and retinal hæmorrhages were present; the symptoms started with a central or paracentral scotoma. Of fourteen reported cases six were unilateral. Three cases are reported by Nettleship[3]; the recovery on weaning was almost complete, and George Derby[4] contributes a valuable addition to our knowledge of this subject.

MONGOLIAN IDIOCY.

This term is applied to a form of imbecility which occurs in quite young children in association with marked physical abnormalities.

These abnormalities as they affect the face, are responsible for the irregularity of contour of the bony orbits, with the obliquity of the attached ligaments and tarsal tissues, giving

[1] *Quarterly J. of Med.*, 1913-14, vii., 237.
[2] *Annales d'Oculistique*, 1912, cxlvii., 321.
[3] *Royal Lond. Ophth. Hosp. Reports*, 1893, xiii., 97.
[4] Archiv. of Ophth., 1905, xxxiv., 9.

the palpebral fissures their obliquity of direction, the lids their shortness and epicanthus, and the eyes their apparent faulty situation ; it is these characters which are responsible for the naming of the type.[1]

Amongst other physical characters are dwarfism, a flattened nose, a protuberant lower lip, a large tongue the mouth being usually kept open, small and malformed hands, flat feet and a wide gap between the first and second toes.

The children are mentally defective, but are of a happy disposition ; they seldom reach adult age.

Ormond [2] has examined the eyes of forty-two cases, thirty-two males and ten females. He points out that some disease of the eyes or lids is exceedingly common.

In over fifty per cent. of his cases some form of lenticular opacity was present. In some the opacity was of the lamellar type, in others a section of the lens was opaque or the opacity was of the dot variety. The youngest patient with cataract was aged six-and-a-half years ; the oldest was forty-three.

Other abnormalities were :—

Nystagmus . . .	11·9 per cent.
Squints	21·4 ,,
Blepharitis or ectropion .	42·8 ,,
Epicanthus . . .	26·2 ,,

ACUTE CEREBRAL AMAUROSIS OF INFANCY.

Under the above title, Gay [3] and Nettleship [4] have each published a series of cases of sudden blindness occurring in infants or young children, associated with meningitic symptoms, and most often ending in recovery.

Gay says : " The eye symptoms in this series of cases seem to me to constitute an ophthalmological entity, characterised by blindness, but unaccompanied by any change in the disc or fundus, and following upon cephalic symptoms of an undeterminate character, although, as a rule, suggestive of meningitis.

[1] Oliver, *Trans. Amer. Ophth. Soc.*, 1891, vi., 140.
[2] *Trans. Ophth. Soc. U.K.*, 1912, xxxii., 69.
[3] *Royal Lond. Ophth. Hosp.* (*Moorfields*) *Reports*, 1893, xiii., 404.
[4] *Trans. Ophth. Soc. U.K.*, 1884, iv., 245.

The tendency of such cases is usually towards recovery, but sometimes atrophy of one or both discs ensues and the blindness becomes permanent. The characteristics are—sudden onset of blindness, associated with a febrile attack with convulsions, cervical opisthotonos, weakness of the back and legs, and general evidence of meningitis, the pupils are sluggish and inactive, and recovery of sight is usually complete."

Nettleship says blindness may last from one to six months before improvement begins, and recovery takes place rather slowly ; on the other hand, some cases recover quickly, indeed, within a few days. In a few cases—three out of fourteen—permanent blindness with secondary optic atrophy ensues.

Sometimes blindness seems to be the only symptom. There is no doubt that the great majority are instances of post-basic meningitis (*q.v.*), as was shown by Barlow and Lees, and it is not clear that any other condition gives rise to the foregoing clinical picture.

CHAPTER VIII

Snow blindness—Eclipse blindness—Electric amblyopia—Lightning—Neuroparalytic keratitis—Retro-bulbar neuritis—Oyster shucker's keratitis.

SNOW BLINDNESS.

This condition is an affection of the superficial parts of the eye, the conjunctiva and cornea, and so is related to the similar conditions which arise in "electric ophthalmia," and is quite distinct from eclipse blindness.

It shows itself by photophobia, blepharospasm, hyperæmia and increased secretion from the conjunctiva, and sometimes by the formation of an erosion or bulla on the cornea.

The symptoms usually come on some hours after the exposure, but may result in so short a time as fifteen minutes if the eyes are unprotected.[1]

It is light reflected from snow which is chiefly active, and Windmark has shown that such light is especially rich in ultra-violet rays; it may occur on dull, cloudy days as well as in sunny weather.

Daland [2] examined 3,000 Eskimos and showed that they are not immune to snow blindness, and that one attack predisposes to future attacks. He states that it also occurs in animals.

In addition, Atkinson,[1] from his South Polar experience, describes a temporary diplopia which persists for several days and completely recovers. This he attributes to the tiring of the external and internal ocular muscles, and is caused by difficulties of vision through lack of contrast when the air is so thickly filled with ice crystals that it is impossible to see more than a yard or two ahead.

[1] Atkinson, *Brit. Jour. of Ophth.*, 1921, v., 50.
[2] *Ophth. Rec.*, 1917, xxvi., 116 and Trans. Coll. Physic, Philadelphia, 1916, xxxviii., 370.

ECLIPSE BLINDNESS.

There is a group of cases in which an over-stimulation of the retina results in a great temporary impairment of its functions, and sometimes ends in a permanent visual defect.

The best known and most frequent of the causes is from looking directly at the sun, and as this form is most often encountered in those who have been watching an eclipse, it is often called "eclipse blindness."

Amongst other similar causes are blindness from sudden intense electric flashes.

If the eyes are closed immediately after viewing the sun, a bright after-image is seen, which rapidly changes in colour and soon disappears.

With regard to this, Mackay[1] says: "The persistence, on closing the eye, of a sun image which does not rapidly undergo alteration in colour, may perhaps be taken as the mark of a retinal stimulus which has slightly surpassed physiological limits."

Most observers agree, that following the exposure to the sun, an interval of an hour or two or longer elapses, before the patient is aware of a visual defect.

Lawford[2] reports a case in which the defect was not observed for ten days; in Collins' case there was progressive deterioration for a week.

In all cases there is a partial central scotoma which is more complete for colours; in the course of time this almost completely disappears in most cases, but as a rule, some slight residue will be found if the examination is sufficiently careful.

Occasionally a serious permanent defect remains, thus the case of a patient in whom the vision fell to 1/20 and never recovered beyond 1/2 is reported by Dufour,[3] and Treacher Collins[4] reports the case of a woman of forty-nine who, having looked at the sun for about seven minutes, was almost blind in the left eye at the end of a week; seven

[1] *Ophth. Review*, 1894, xiii., 1, 41 and 83.
[2] *Trans. Ophth. Soc. U.K.*, 1901, xxi., 77.
[3] Quoted by Mackay.
[4] *Royal Lond. Ophthalmic Hospital (Moorfields) Reports*, 1897, xiv., 374.

years later she could only count fingers with this eye, and the appreciation of colour was much interfered with; the optic nerve showed partial atrophy. The peripheral visual field was complete in each eye, and the vision of the right eye was 6/6.

Metamorphopsia is often a little troublesome and may be permanent.

In a few cases a slight disturbance of the pigment of the hexagonal pigment layer may be present, but any marked ophthalmoscopic change is quite unusual; that, however, organic changes may occur is shown not only by the clinical case referred to, but also by Deutschman's experiments.[1] He focussed a strong light into the eyes of rabbits, and produced not only ophthalmoscopic changes, but also a limited area of disorganisation of the retinal tissues, which was found upon histological examination.

Prognosis.—The prospect as to recovery in all but the most severe cases is good, and it is unusual for the patient to be bothered by any defect that may remain.

The time taken in recovery is tabulated by Mackay as follows:—

Group 1.—A patient with V = 1/3 or better in the first week has a good chance of practical recovery in one month.

Group 2.—A patient with V = 1/3 or better in the second week has a good chance of practical recovery in three or four months.

Group 3.—A patient with V = 1/3 or better in the third week has a good chance of practical recovery in five or six months.

Group 4.—A patient with V = less than 1/3 seems to have a bad chance of recovering V = 6/6.

By practical recovery is meant cessation of obtrusive defect.

ELECTRIC AMBLYOPIA.

It is common to find a temporary incomplete central scotoma, and injection of the vessels of the conjunctiva, following exposure to a momentary intense short circuit flash, and

[1] von Graefe's *Archiv. f. Ophth.*, 1882, xxviii., iii., 241.

similar symptoms may arise in those who have to do with intense light of any kind.

Panas [1] saw forty-five cases of eye trouble in two years from short-circuit flashing in the "Metropolitain." The symptoms were conjunctival injection, superficial burns, blepharospasm, diminished vision and contracted fields. He states that acute forms of conjunctivitis, with photophobia and pain in the head, are common in large electrical works following exposure to short circuiting. Of his cases many recovered in three or four weeks, but in a considerable number symptoms persisted for three or four months.

LIGHTNING.

A few cases are on record in which the eyes have been affected by a lightning flash, in some of which organic damage resulted.

The most common change is the development of lenticular opacities, in other cases striæ in the cornea have been seen, and in a few optic atrophy has subsequently developed; temporary photophobia is common.

Gonin [2] reports a case in which the patient was unconscious for a quarter of an hour after being struck. The corneæ were hazy for a few days, the retinal vessels were constricted, and the optic discs were pale; he attributes further deterioration of vision to optic atrophy. Radiating opacities were present in the posterior layers of the left lens, and twelve months later punctate opacities were observed in the right lens.

He reviews thirty reported cases, of which twenty-two had lens opacities.

Leber [3] found nine cases of cataract amongst eighteen similar cases.

NEUROPARALYTIC KERATITIS.

In cases where the functional continuity of the trigeminal nerve is interrupted, whether by disease or as the result of operation for the relief of intractable neuralgia, the cornea is very liable to become ulcerated.

[1] *Archiv. d'Ophtal.*, 1902, xxii., 625.
[2] *Annales d'Oculistique*, 1904, cxxxi., 81.
[3] *Archiv. f. Ophth.*, 1882, xxviii., iii., 255.

Different views have been held as to the cause of this change, as to whether it is due to exposure and trauma unnoticed by the insensitive cornea, or whether it is due to the removal of some trophic influence. Fuchs [1] says: "If in a case of trigeminal paralysis in which the eye is still healthy, we hold the lids apart for one or two minutes with the fingers, and thus prevent moistening of the cornea, small depressions, which soon enlarge and become confluent, appear in the epithelium . . . a healthy eye does not show these pits at all, or does so only after a long time. These pits prove a diminished resistance of the corneal epithelium to desiccation, and consequently a disturbance of its nutrition which was present before the desiccation began.

"Diminished moistening is, therefore, certainly more injurious for such eyes than for normal ones. But, as above stated, neuroparalytic keratitis may develop, even when the cornea is kept permanently covered. Desiccation, therefore, is to be regarded only as a favouring factor, not as the final cause of keratitis neuroparalytica. Such a cause is found in a disturbance of nutrition of the cornea (and particularly of its epithelium) produced by the loss of innervation. As a result of this disturbance of nutrition, the resisting powers of the cornea is so reduced, that the latter is thrown into a diseased condition by external influences which are so slight, that a normal eye would not have been injured by them."

In the early stages of the condition the corneal epithelium is desquamated over a small area; this process spreads until the whole of the cornea, except for a narrow ring-like margin all round, appears to be completely denuded, and stains a bright green if fluorescin be dropped into the eye.

At the same time, the eye shows comparatively little injection and pain is absent; the whole picture is distinctive and unlike any other condition.

In the later stages, infiltration of the substantia propria becomes more extensive till it has a yellow colour, pus collects in the anterior chamber, the cornea perforates, the eye ultimately being completely spoiled.

[1] "Text-book of Ophthalmology," 1908, 194.

A case of Caisson disease, in which, among other symptoms, there was anæsthesia of all the branches of the two first divisions of the fifth nerve with neuroparalytic keratitis, is reported by Harlan.[1]

ACUTE RETRO-BULBAR NEURITIS.

Under this term are included cases of the local implication of the optic nerves, by toxins or inflammatory processes, which lead to great loss of sight.

Those cases which are brought about by the direct extension of an inflammatory process in the orbit to the optic nerve need not be considered here, and the toxic amblyopias are dealt with separately.

There is, however, a group of cases for which no satisfactory cause is found, which is characterised by loss of sight, which develops within two or three days and usually affects one eye only; pain on movement of the eyeball and neuralgic pains in the temple; a pupil which contracts to light, but the contraction of which is not maintained; and a normal fundus. The pain usually precedes the loss of sight and does not last more than a few days. In many cases a central scotoma is present. It is usual for complete recovery to occur, but in six out of twenty cases, Nettleship [2] found the sight was entirely and permanently lost, and in these cases optic atrophy occurred.

No cause is known, and consequently such cases are often attributed to gout or rheumatism.

OYSTER SHUCKER'S KERATITIS.

This is an interesting form of acute corneal ulcer which results from the impaction of minute fragments of the shell of the oyster in the cornea. It is of frequent occurrence in Baltimore, where there is a large oyster industry, and where the edge of the shell is chipped off with a hammer, preparatory to introducing the knife to prise the shell open.

The condition has been investigated by Randolph; [3] he

[1] *Trans. Amer. Ophth. Soc.*, 1897-98, viii., 107.
[2] *Trans. Ophth. Soc. U.K.*, 1884, iv., 186.
[3] *Trans. Amer. Ophth. Soc.*, 1894-96, vii., 313.

describes the ulcer as whiter than other ulcers, having a sharply defined edge, and showing little tendency to spread. He showed by experiment that the nature of the ulcer was apparently due to the chemical nature of the shell fragment.

Ulcers, which have a good deal in common with the above, are seen in those occupied in scraping the hulls of ships. There is a reaction out of all proportion to the size of the ulcer, which is very slow in healing, and it is probable that it is the chemical nature of the minute fragments which enter the eye which is responsible for this particular type of ulcer.

CHAPTER IX

Tobacco—Alcohol—Methyl alcohol—Quinine—Sodium salicylate—Lead — Silver nitrate — Iodoform — Carbon di-sulphide — Nitrobenzol — Aniline — Phenol — Ochronosis — Naphthaline — Antipyrin—Santonin—Aspidium (*Filix Mas*)—The arylarsenates —Æthylhydrocuprein (Optochin).

TOBACCO AMBLYOPIA.

The most universal form of toxic amblyopia is that which is caused by tobacco, whether by smoking, chewing or snuff-taking, or as has been shown by de Schwenitz, it may occur in those who work in tobacco factories, even though they neither smoke nor chew tobacco.

The prominent features of the condition are impairment of central vision with a central or para-central scotoma for red and green, an intact peripheral field, complete recovery on stopping smoking, and a normal or nearly normal fundus.

The subjects of the disease are often copious drinkers of alcohol, and the view has been held that the loss of vision is due to the combined effects of the two noxious agents, consequently the term "alcohol-tobacco amblyopia" has come to be used by some.

That, however, the loss of sight may result from tobacco alone in the absence of alcohol is shown by Connor,[1] who collected twenty-seven such cases, and by Lanckton Foster.[2] Further, the lost vision may be restored by stopping smoking, alcohol being continued as before.

Jonathan Hutchinson's remarks are interesting in this connection.[3] He says: "Total abstainers from stimulants are more liable to suffer than others, and although we sometimes meet with the disease in the intemperate, I have a strong

[1] *Jour. Amer. Med. Ass.*, 1890, xiv., 217.
[2] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 516.
[3] *Royal London Ophth. Hosp. Reports*, 1874, viii., 456.

impression that, on the whole, alcohol counteracts tobacco"—a view which finds few if any adherents.

There is no doubt that a debilitated condition predisposes to the poisoning, and perhaps this is especially true of diabetes; it has, however, to be borne in mind that an amblyopia which is proper to this latter disease may occur (p. 171).

Incidence.—The disease for obvious reasons is much most frequent in men; it comes on only after smoking has been continued for some years; it is uncommon under the age of thirty, and the years between thirty-five and fifty-five embrace the greatest number of cases.

In the course of eleven years, amongst 12,644 ophthalmic out-patients, Priestley Smith [1] found a percentage of 1·20 of tobacco amblyopia.

It is most frequently brought on by pipe smoking, and by strong shag tobacco, less often by cigars, and rarely by cigarettes. Van Millingen [2] states that in Turkey, where smoking is extensively practised both by men and women, amblyopia is unknown, a fact which he attributes to the mildness of the tobacco, and to the fact that it is almost entirely cigarettes which are smoked.

The amount of tobacco which is necessary for the production of amblyopia varies with the kind of the tobacco, and especially with the susceptibility of the patient, and inquiry will often elicit the fact that whilst a very modest amount is at present confessed to, a month or six weeks previously it was much larger in amount, the fact being that these folk have often independently concluded that smoking was the cause of their trouble.

The degree of amblyopia is, with very few exceptions, approximately equal in the two eyes, but a few marked exceptions have been reported.

All cases improve with complete cessation, most with mere reduction of smoking. It may be safely assumed, either that smoking has not been stopped, or that the diagnosis is incorrect, if no improvement takes place in three months.

[1] "Report of the Committee on Colour Vision," Roy. Society, London, 1892.
[2] *Trans. Ophth. Soc. U.K.*, 1888, viii., 240.

It might well have been expected that a patient who had once shown himself susceptible to the poison by developing amblyopia, would be likely to have a recurrence on resuming the habit, but recurrences are seldom seen, and whilst chronic tobacco poisoning may produce marked disturbances of digestion, of the heart's action, and of mental ability, it is common to find none of these prominent in cases of tobacco blindness.

There are no characteristic or marked ophthalmoscopic changes, and such as have been described are so often seen under purely physiological conditions, that their diagnostic value is almost negligible.

The chief change described is a pallor of the lower temporal part of the disc; a few other quite indefinite changes have been described. De Schweinitz states that "under rare circumstances complete atrophy ensues," and Nettleship [1] that "in severe cases of long standing a general pallor of it (the disc) may occur."

Visual Fields.—Whilst the peripheral boundaries of the visual fields are normal, there is a scotoma for red and green between the blind spot and the point of fixation.

At first the scotoma is for colour only, but later it may become absolute even to light perception.

An important form of blindness which occurs in New South Wales in horses has been described by Kendal and Cameron [2] and Barrett,[3] which is believed to be due to the ingestion of the Australian tobacco plant (*Nicotiana suaveoleus*).

On the other hand, de Schweinitz states that the Virginia deer eat the leaves of the tobacco plant (*Nicotiana tabacum*) without detriment; he suggests that they have become immune to the drug by reason of many years' residence in the tobacco district, just as the monkeys of certain districts of the East Indies are said to eat the seeds of the *Strychnos nux-vomica* without harm, whilst to other tribes of monkeys they are a deadly poison.

Pathology.—It cannot be said that the anatomical site of the primary lesion has been made certain.

[1] *Trans. Ophth. Soc. U.K.*, 1887, vii., 38.
[2] Quoted de Schweinitz, "Toxic Amblyopias," Philadelphia, 1896, 95.
[3] *Intercolonial Med. Jour. of Austral.*, 1897, ii., 172.

Fisher [1] argues on theoretical grounds, having regard to Langley's work on the action of nicotine on ganglion cells and their synapses, that the block in transmission probably lies between the macular cones and their ganglion cells.

Parsons [2] has shown that there is no discoverable change in the cells of the superior cervical ganglion of rabbits as a result of soaking them in a 1 per cent. nicotine solution in normal saline.

He suggests as a tentative working hypothesis [3] that the defect is due in part to :—

(1) Constriction of the arterioles, which would explain the selective choice of the macular region in which the vascular supply is sparse.

(2) Paralytic action upon the synapses either of the cone fibres or of the bipolars or both.

Birch-Hirschfeld [4] examined the eye of a man who had had tobacco amblyopia for seven years ; he describes degeneration of the retinal ganglion cells and atrophy of the nerve fibres with secondary changes in the interstitial tissues.

Dalén [5] obtained the eye from a man a few hours after death who had had symptoms of amblyopia for nine weeks only ; he found degeneration of the papillo-macular bundle.

De Schweinitz [6] comes to the conclusion that the appearances correspond closely with those usually ascribed to an interstitial sclerosing inflammation, with secondary nerve atrophy, rather than a primary nerve atrophy with secondary interstitial change ; he says " the situation of the pathological process is in the optic nerve, and especially in that portion which is known as the papillo-macular bundle.

AMBLYOPIA FROM ALCOHOL.

A number of observers have doubted whether alcohol alone is ever responsible for amblyopia, and whether the cases which

[1] *Ophth. Review*, 1901, xx., 151.
[2] *Jour. of Physiol.*, 1900, xxvi., xxxviii.
[3] *Ophth. Review*, 1901, xx., 189.
[4] v. Graefe's *Archiv. f. Ophth.*, 1902, liii., 79 ; and 1902, liv., 68.
[5] *Mitteilungen aus der Augenklinik. des Carolinischen Medico-Chirurgischen Instituts zu Stockholm*, 1906, viii.
[6] *Trans. Amer. Ophth. Soc.*, 1897-98, viii., 186.

have been attributed to it are not due to other poisons, such for example as fusel oil (Fuchs) used as an adulterant, tobacco, or the results of perverted metabolism as in diabetes.

Thus, at a special meeting of the Ophthalmological Society of the United Kingdom for the consideration of toxic amblyopias,[1] Nettleship said : " I have seen no case of amblyopia in drinkers who did not smoke," and with this view, Gunn, Morton, Frost, Berry and Shears all concurred.

A diagnosis of alcoholic amblyopia is certainly very seldom made in England, and it is of course patent, that in an alcoholic subject, other causes of retro-ocular neuritis must be excluded before the condition can be attributed to the alcohol.

Leber's disease has certainly been overlooked in some cases, and unless the use of tobacco can be entirely excluded, a certain degree of doubt as to the true cause of the visual defect must remain.

Nevertheless, certain authoritative observers in America [2] and Germany have been satisfied that amblyopia may result from chronic alcoholism ; de Schweinitz states that " extensive investigations and the reports of cases render it certain that a definite form of amblyopia is caused by alcohol, and is one of the conditions present in chronic alcoholic poisoning, even when this occurs in people who are not addicted to the use of tobacco."

Peripheral alcoholic neuritis is often combined with the loss of sight.[3]

Incidence.—In the investigation of 204 cases of retro-bulbar neuritis, Uhthoff [4] found 138 were due to toxic causes, and of these 138 he attributed—

64 to alcohol.
45 to alcohol and tobacco.
23 to tobacco.
6 to other causes.

It has, however, to be noted, that cases were attributed

[1] *Trans. Ophth. Soc. U.K.*, 1887, vii., 36.
[2] Connor, *Jour. Amer. Med. Ass.*, 1890, xiv., 217.
[3] Fuchs, " Text-book of Ophthalmology," 1908, 527.
[4] v. Graefe's *Archiv. f. Ophth.*, 1886, xxxii., iv., 95; and xxxiii., i., 257.

to alcohol by him, when this was taken to excess and tobacco was used in moderation, and cases attributed to tobacco in the contrary circumstances; as will be seen, in forty-five cases Uhthoff did not feel able to discriminate.

Signs and Symptoms.—The most frequent ophthalmoscopic evidence, according to Uhthoff, is a pathological whiteness of the temporal half of the papilla. Thus, of 1,000 patients suffering from severe alcoholism in two large asylums examined by him, 139 had paleness of the temporal halves of the disc, and sixty of them suffered from amblyopia. To control this observation, Uhthoff examined 100 normal men and 1,000 lunatics who were not alcoholic, and in each case he found about 1 per cent. only with paleness of the temporal part of the disc. It has, however, to be remembered that normally the temporal half of the disc is paler than the nasal half.

Occasionally, haziness of the nerve head and hyperæmia of its surface are present, but such findings as these so readily invade the broad field of physiological variation that they cease to be important.

In the early stage there is a relative central scotoma for red and green; sometimes complete or partial peripheral defects for these colours occur, and sometimes an absolute central scotoma develops. The pupil reactions are unaltered. The prognosis is said to be less favourable than in tobacco and other toxic amblyopias, especially if there is commencing pallor of the disc; there is in addition the great difficulty of insuring abstinence from drink.

Histological.—In a number of instances the optic nerves, chiasma, and tracts have been carefully examined histologically by Samuelsohn,[1] Nettleship and Edmunds,[2] Uhthoff and others.

The changes in alcoholic cases are distinct from those which are seen in the primary optic atrophy of tabes or general paralysis. In the latter, the connective tissue of the nerve is not thickened, its network is unaltered, but the finest twigs of the network are atrophic; in alcoholic neuritis these finest twigs are thickened and proliferated.

[1] v. Graefe's *Archiv. f. Ophth.*, 1882, xxviii., i., 1.
[2] *Trans. Ophth. Soc. U.K.*, 1881, i., 124.

In alcoholic cases the connective tissue network may be completely obliterated and the nerve substance entirely disappear, a condition which does not ensue in cases of primary atrophy. And again, in a case of primary atrophy which affects a part only of the nerve, Uhthoff states that normal fibres are never present within this part, whereas in alcoholic cases they are frequently seen. The preservation of these healthy fibres within the diseased areas explains why alcoholic neuritis of the optic nerve seldom leads to complete blindness.

These changes are thus summed up by de Schweinitz :

" Most of the investigations show that the anatomical basis of this affection consists of an augmentation of nuclei, hypertrophy of the connective tissue, and wasting of the nerve fibres of a limited portion of the optic nerve known as the papillo-macular bundle ; in fact, that there is an interstitial, sclerosing inflammation, comparable, according to Samuelsohn, to the same pathological process which alcohol produces in the liver in interstitial hepatitis."

The position of the papillo-macular bundle of fibres is as follows, quoted from de Schweinitz :—

" The papillo-macular bundle, according to Bunge's nomenclature, which consists of those fibres in the optic nerve which supply the retina between the macula lutea and the papilla, and are more or less diseased in all of these cases, lie in the temporal portion of the nerve tip in a wedge-shaped segment.

" The triangular portion is directed with its apex towards the vessels and occupies about one-third of the surface of the papilla.

" As it pursues its way through the orbital portion, it gradually approaches the axis of the nerve which it reaches in the optical canal.

" At the front of the chiasm it occupies its upper and inner portion, but in the tracts it sinks to the central portion, and remains there till it arrives at the brain.

" With the entrance of the vessels into the optic nerve trunk, the cross-section of the diseased fibres quickly, according to Samuelsohn, or gradually according to other observers, pre-

sents the form of an oval, reaching from the temporal side of the optic nerve more towards the centre.

"In the intra-cranial portion of the optic nerve the bundle first reaches a central position, whilst in the chiasm and the tractus it occupies the positions just noted."

Bunge believes that the papillo-macular bundle divides into two portions in the posterior portion of the chiasm, an upper and a lower part, while Vossius finds this division in the tractus.

WOOD ALCOHOL BLINDNESS.

Very rapid, severe, and permanent damage to the sight may occur from the absorption of wood alcohol into the system either when taken by the mouth or when absorbed by inhalation. It is a form of poisoning which seems to be of more frequent occurrence in America and Germany than in England.

Blindness follows rapidly on the absorption of the drug, the pupil is dilated, there is intense œdema of the retina, and neuritis [1] followed by optic atrophy.

In some of the less severe cases, after blindness has persisted for a few days, recovery sets in and is occasionally complete. Ziegler reports a case in which recovery commenced after so long as two months. In more severe cases death is not an uncommon sequel; in others, the blindness persists and becomes absolute and permanent, the optic nerve undergoing atrophy.

In some cases the alcohol has been taken by mistake, in some it has been used as an adulterant, and in some it has been absorbed by inhalation during some commercial process. Wilmer [2] reports the case of a soldier who took 4 drachms in mistake for whiskey; next morning his sight was poor, and on the fourth day he was practically blind, and so remained. Gruening [3] says: "Wood alcohol poisoning is very common throughout the States; wood alcohol is used in many

[1] Fridenberg, *Trans. Amer. Ophth. Soc.*, 1909-11, xii., 514.
[2] *Trans. Amer. Ophth. Soc.*, 1909-11, xii., 523.
[3] *Trans. Amer. Ophth. Soc.*, 1909-11, xii., 522.

beverages." Mendel [1] reports the accidental poisoning of a large gathering of individuals; 130 were transferred to hospital, of whom fifty-one died; many became blind before death. Four patients were exhibited, all of whom had pale, white atrophic discs.

As instances of poisoning by inhalation, Tyson [2] reports the case of three men who were occupied on shellacing the interior of a large vat, the shellac being dissolved in wood alcohol; two of them died and one became blind: de Schweinitz [3] reports the case of a man who worked in a close space with Columbian spirits which contains about 95 per cent. of wood alcohol; he also became rapidly and permanently blind from inhaling the spirit.

Birch-Hirschfeld [4] experimenting on four dogs and three monkeys found marked changes in the retinal ganglia before any morbid change could be traced in the optic nerve. He believes that the primary action is upon the ganglion cells, and that an ascending degeneration of the nerve follows, the changes in the neuroglia and septa being secondary only.

Fridenberg explains the action of the alcohol as due "to an intense œdema with some neuritis, followed rapidly by optic nerve atrophy, and due to formalin or formic acid circulating in the blood, as a result of incomplete combustion of methyl alcohol ingested." Kelly [5] reports the case of one of a coterie of six congenial spirits who were taken ill after a convivial evening together. His patient was suffering from severe loss of sight after taking two Bronx cocktails, and of the five remaining, four were dead and one was blind.

QUININE.

The susceptibility of different individuals towards the toxic effects of quinine varies greatly. I have seen a woman who, not knowing of this effect of the drug, stated that if she took a

[1] *Berlin Ophth. Gesells.*, 1912.
[2] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 146.
[3] *Trans. Amer. Ophth. Soc.*, 1909-11, xii., 523.
[4] v. Graefe's *Archiv. f. Ophth.*, 1902, liv., 68.
[5] Quoted Clairborne, *New York Acad. of Med.*, Ophth. Section, 1919.

teaspoonful of the ammoniated tincture, *i.e.*, 1 grain of the drug, her sight has dimmed for a quarter of an hour; on the other hand, what large doses are tolerated by many malarial patients! and it is stated that so much as an ounce has been taken without disastrous results.

This drug is taken by some women as an abortifacient, a practice which supplies a proportion of the ophthalmic cases that one sees. On asking a woman why she had taken it, she said: "Oh! you know!" She had evolved a formula for its use; if she missed a period she took a penn'orth, and if she did not abort within three days she took three-penn'orth of the drug, a quantity which no doubt varied greatly with the generosity of the druggist.

I asked her if many women took it. She said: "Yes, I know a woman who is experimenting with it now."

The late George Coats had a man under observation for some years who went blind from having taken within twenty-four hours, two bottles of a proprietary orange and quinine wine. I saw him four years afterwards; his fields were greatly restricted, the retinal vessels were very attenuated, and the discs were white.

Bruns reports the case of a child of three who was given five grains by the rectum within eighteen hours for remittent fever, and in whom ophthalmoscopic changes and visual defects persisted ten years later.

Harlan [1] reports the case of a man of thirty-four who took 200 grains of quinine and who was blind for ten days; improvement then set in, and seven weeks later the visual fields extended outwards to about 25 degrees all round, and his central vision was largely restored.

Symptoms.—The first toxic symptom is tinnitus and deafness, which most often is temporary only, loss of sight follows within a few hours and is often severe and may be absolute; the pupils are widely dilated and are inactive to light; the retinal vessels show extreme tenuity, and the disc and fundi are very pale; complete loss of consciousness may occur.

The degree to which sight is affected varies greatly, from a

[1] *Ophth. Record*, 1897, vi., 113.

temporary obscuration to complete blindness, but in all cases the tendency is towards recovery, and it is doubtful whether absolute permanent blindness ever ensues in man.

Onset.—The onset may be gradual and take several days for its development, but it is more usual for it to occur within a few hours ; on the other hand, with large doses it is often quite sudden.

A sea captain feeling " a cold " coming on, knocked out some quinine on to the palm of his hand and swallowed it. Seven hours later, whilst looking out to sea, it was, he said, exactly as if a shutter had been let down over his right eye, and one second later the sight of the left eye was blotted out as suddenly ; it was twenty-four hours before he saw even the glimmer of an electric light.

Its duration may be a few hours or even less, but in cases of any severity, there is a period of total blindness in which light perception is absent, and this period may be from a day or two to several weeks. In a case of Dewey's [1] this blindness lasted for three months, and at the end of eighteen months there were still serious visual defects.

In dogs experimented on by de Schweinitz there was in some cases still total blindness at the end of two months.

The visual fields show a marked peripheral constriction, and except in the mildest cases some degree of this defect is permanent ; central vision is affected much less severely.

Barabaschew [2] experimented on six of his willing colleagues in order to observe the effects upon healthy individuals. Each took from 40 to 60 grains of quinine hydrochlorate, and three of them presented definite symptoms. The phenomena observed were :—

Pallor of the face and conjunctiva.
Marked contraction of the retinal vessels and pallor of the optic discs.
Diminution of visual acuity.
Concentric constriction of the visual fields.

[1] *Trans. Med. Assoc. Missouri*, 1882, 161.
[2] *Westnik Ophth.*, 1891, viii., i., 14 ; and *Archiv. f. Augenheilk.*, 1891, xxiii., 91.

And of less recognised symptoms :—

Temporary increase of visual acuity lasting some hours.
Contraction of the pupil lasting some time, followed by moderate dilatation.

Complete amaurosis occurred in one case only, and lasted a very short time. Marked ischæmia of the retina occurred in all cases, and in two the pallor resembled optic atrophy.

In those cases in which symptoms of any marked degree persist, the special ophthalmoscopic feature, in addition to pallor of the disc, is a great constriction of the retinal arteries.

Several observers have commented upon the liability to relapse after small doses of the drug.

In some cases in the early stage, according to Gruening,[1] a cherry red spot at the maculæ may be seen with surrounding grey retinal haze; this, however, was not observed by Barabaschew.

Experimental.—Experimental work on dogs by Holden [2] and de Schweinitz [3] shows that as early as the third day there is marked degeneration in the ganglion cells of the retina, and later, by the forty-second day, only a few normal ganglion cells remained; consequent upon this, degeneration takes place in the optic nerve fibres extending to the mid-brain; the other layers of the retina are not affected.

In the case of a dog, blind for sixty-one days, de Schweinitz says: "In none of the sections is there any indication of disease of the vessels of the uveal tract." He looks upon the process as due to the direct action of the drug upon the peripheral vessels, which, by deprivation of blood, causes the degeneration of the nerve cells. He shows that there are no changes in the cells of the visual cortex. Organic changes in the vessels is a late and secondary process.

De Schweinitz shows sections of the ciliary ganglion and the third nerve which are entirely free of change, thus emphasising how selective is the action of the drug upon the retina.

[1] Quoted by de Schweinitz, "Toxic Amblyopias," Philadelphia, 1896, 184.
[2] *Trans. Amer. Ophth. Soc.*, 1897-98, viii., 405.
[3] *Trans. Amer. Ophth. Soc.*, 1891-93, vi., 23; 1906-8, xi., 338; and *Trans. Coll. Phys. of Philadelphia*, 1890, xii., 185.

SODIUM SALICYLATE.

Temporary loss of sight occurs at times from large doses of the salicylates; the effects are similar to those of quinine, but are less severe in degree and probably are never permanent.

The arteries are reduced in size, the pupils are dilated and inactive, and deafness and tinnitus occur. Recovery is more rapid and complete than in quinine blindness.

De Schweinitz [1] experimented on dogs and showed that blindness could be produced in them. He says: "It is possible to produce partial blindness with large doses of salicylic acid or salicylate of soda, the ophthalmoscopic appearances resembling in minor degree those seen in quinine amaurosis."

Gatti [2] reports the case of a sixteen-year-old girl who was given 8 grammes of salicylate of soda in ten one-hourly doses. After receiving the last dose she fell asleep, and awoke blind; there were no marked ophthalmoscopic signs; in twenty-four hours vision was restored. Snell [3] reports the case of a girl of nine who was given 150 grains of the sodium salt in sixty hours for acute rheumatism; she became quite blind and was unable to tell light from dark, and this condition remained till her death. The pupils reacted to light, the fundi were normal, there was no deafness or tinnitus.

LEAD.

It has for long been known that the vision and ocular muscles may be seriously affected in poisoning by lead. Sometimes the ocular complications, especially retinitis and optic neuritis, arise as a manifestation of vascular or renal disease which is produced by the poison, and Jeaffreson [4] has expressed doubt whether such lesions can be produced by the lead direct; that, however, such may occur seems to have been made clear by Oliver.[5]

Lead may be introduced into the body by several paths; it may be absorbed through the skin, or inhaled as dust, or taken

[1] "Toxic Amblyopias," Philadelphia, 1896, 205.
[2] Quoted by de Schweinitz.
[3] *Trans. Ophth. Soc. U.K.*, 1901, xxi., 306.
[4] *Brit. Med. Jour.*, 1886, i., 390.
[5] *Brit. Med. Jour.*, 1885, ii., 731.

into the system by the mouth ; most cases occur as a result of some industrial process in which lead is used, and amongst individuals who are regardless of the precautions advised, or are careless as to their observance.

Gibson [1] reports an epidemic-like occurrence in children, of whom sixty-two were admitted to the Brisbane Hospital for Sick Children in three years. In them the source of the lead was traced to the lead carbonate in the white paint with which the railings around the houses were painted.

Frequency.—Amongst Gibson's sixty-two cases, thirteen had eye symptoms. Amongst 138 cases of toxic amblyopia, Uhthoff found one only due to lead, and Norris [2] found three cases of saturnine amblyopia amongst 15,000 cases of eye diseases.

Males, in general, are more liable to suffer than are females in the proportion of forty-six to twelve,[3] owing to the occupational incidence of the poisoning ; patients of all ages may be affected.

There is great variation in the time interval between the first exposure to the poison and the onset of eye symptoms, varying, no doubt, with the thoroughness of the precautionary measures, but also depending upon the varying susceptibility which different individuals possess ; thus, it is stated by de Schweinitz that symptoms may arise within twelve days of exposure ; on the other hand, there may be immunity at the end of many years.

It is quite unusual to find eye symptoms without other undoubted evidence of chronic plumbism being present, *e.g.*, wrist drop, colic, headaches, blue line in the gum, lead in the urine, etc.

The most useful classification of the types of ocular lesion is that given by de Schweinitz, thus :—

(1) Transient amblyopia without ophthalmoscopic change, due to an anæsthetic effect of the lead on the retina and optic nerve, and not unlike amaurosis from uræmia without fundus lesions.

[1] *Brit. Med. Jour.*, 1908, ii., 1488.
[2] Quoted Brose, *Archives of Ophth.*, 1915, xliv., 27.
[3] Stood, v. Graefe's *Archiv.*, 1884, xxx., iii., 215.

This type is clearly defined, the onset is rapid, and the recovery rapid—within a few days—and complete; it is referred to by Loewe [1] and Galezowski.[2]

(2) Permanent amblyopia without distinct fundus changes, or at most, some hyperæmia of the nerve-tip and undue filling of the retinal circulation, due to a retro-bulbar neuritis analogous to that occurring under the influence of other toxic agents. This type may terminate in blindness from optic nerve atrophy.

(3) Optic neuritis, or neuro-retinitis, either specifically due to the lead, or secondary to changes in the brain or kidneys.

(4) Optic nerve atrophy, either consecutive to a plumbic papillitis, or due to the primary effect of the lead on the visual apparatus.

(5) Various types of retinitis, often due to lead nephritis, but also primary, and appearing in the form of vasculitis and perivasculitis, as described by Oliver.[3]

Of thirty-four cases examined by Stood,[4] 50 per cent. suffered from optic neuritis or optic atrophy, and of sixty-four cases analysed by de Schweinitz, thirteen had optic neuritis, four neuro-retinitis, seventeen optic atrophy, and seventeen were stated to be blind without a description of the ophthalmoscopic appearances; in nineteen cases the fundi were normal, and therefore belonged to either class 1 or 2.

Subjective colour sensations are not infrequent,[5] and various forms and degrees of colour blindness are seen. Debility of accommodative power is common, and nystagmus is sometimes present. The visual fields may be concentrically constricted, peripheral scotomata may occur, and typical central scotomata, such as are found in intoxication amblyopia, are described by de Schweinitz. The external ocular muscles are not infrequently paralysed, and of them the external rectus is the most common.

Prognosis.—This will obviously depend upon the stage to which the disease has progressed when the patient comes under

[1] *Archives of Ophth.*, 1906, xxxv., 164.
[2] *Archives générales de médicin*, 1906, i., 1613.
[3] "Lead Poisoning in its Acute and Chronic Forms," Edinburgh and London, 1891, 76.
[4] v. Graefe's *Archiv. f. Ophth.*, 1884, xxx., iii., 215.
[5] Folker, *Trans. Ophth. Soc. U.K.*, 1899, xix., 257.

observation, and will be guided by the presence or absence of ophthalmoscopic evidence of organic change in the nerve.

Little improvement can be expected when the optic disc is already white and atrophic; where neuritis or neuro-retinitis is present, removal from the poison holds out a good prospect of improvement; and in the cases of complete blindness of sudden onset, complete recovery may be predicted.

Of five cases reported by Folker, four went blind completely and permanently with atrophic discs and greatly attenuated vessels; Hutchinson [1] reports five cases of optic neuritis with secondary atrophy.

NITRATE OF SILVER.

There are no authentic instances of silver nitrate producing a toxic amblyopia, but Gowers [2] states that its effect is closely analogous to that of lead, and therefore it is highly probable that the same ocular changes may result in some cases.

It is well known that staining of the conjunctiva may result from the prolonged use of silver nitrate or the organic compounds, protargol and argyrol. I have seen argyrosis of the conjunctiva which had developed in three months, as a result of the use, three times weekly, of a 1 per cent. solution of argyrol. I have recently seen a man who was occupied in the manufacture of silver nitrate, the whole of the exposed parts of whose body, face and hands, were as dark as a negro's but of a duller brown. His conjunctiva was of a similar colour, and not only so, but the whole of the surface of the cornea was stained a characteristic dull brown hue. He stated that the colour was distinctly fainter after a holiday, and that he had discarded protective goggles because of the grotesque effect produced, the protected parts soon becoming pale, whilst the rest of his face was black. He was aged seventy-three and was robust; his two predecessors died at the ages of seventy-two and seventy-seven, one of bronchitis and one of "complications"; in neither of them, so far as he knew, did either epitheliomata or warts develop in the skin.

[1] *Royal London Ophth. Hosp. Reports*, 1873, vii., 6.
[2] "Medic. Ophthal.," 1904, 266.

IODOFORM.

A few cases of marked loss of sight are reported as a result of the action of iodoform. In some cases the drug has been taken by the mouth,[1] in other cases it has been absorbed as a result of external application.[2]

In Priestley Smith's case—a man of thirty-one with tuberculous pleurisy and peritonitis—1,000 grains were administered by the mouth in forty-one days; during the last few days he was taking thirty-two grains a day; he then developed amblyopia and other signs of iodoform poisoning. In Critchett's[2] case the drug was being used as a dressing for carcinoma of the breast; in Mohr's[2] cases tuberculous abscesses were injected with iodoform emulsion.

The symptoms of the condition are loss of central vision with no constriction of the visual fields, and no constant or conspicuous ophthalmoscopic changes; there is a general similarity between these symptoms and those of tobacco blindness.

The prognosis seems to be good in all cases when the drug is stopped, the time required for recovery varying with the amount taken and the duration of the symptoms. Priestley Smith's case was very nearly normal in three months; in another case quoted by de Schweinitz recovery occurred in eight days.

BISULPHIDE OF CARBON.

Chloride of sulphur dissolved in bisulphide of carbon is largely used in Parke's vulcanising process, and in certain other processes of manufacture, but it is only in the former process that toxic symptoms arise, since in the latter closed vessels are used.

This chemical was used for a short time by Simpson as a general anæsthetic.

[1] Priestley Smith, *Ophth. Review*, 1893, xii., 101; Hutchinson, *New York Med. Jour.*, 1886, xliii., 16.

[2] Mohr, *Archiv. f. Augenheilk.*, 1902, xlv., 184; Critchett, *Trans. Ophth. Soc. U.K.*, 1898, xviii., 383; Valude, *Annal. d'Oculist.*, 1893, cix., 378.

The first investigations into the profound toxæmia produced were carried out by Delpech,[1] who reported thirty-three cases, fifteen of whom suffered from amblyopia. Cases were then reported by a number of observers, and in 1885 a special committee of the Ophthalmological Society of the United Kingdom was appointed to investigate thoroughly the subject. They tabulated twenty-four cases collected from the literature. That the path of entrance of the poison is through the lungs was clearly established, for men who inhale the vapour are affected, though the liquid never comes into contact with their skin, whilst those who have their hands immersed in the fluid do not develop symptoms if proper masks are worn.

Symptoms.—These may be divided into three stages, as described by the committee.

The earliest is a heavy pain in the forehead and temples which may precede other symptoms by months or years. This is succeeded by a stage of well-marked exaltation of spirits; vision is sometimes affected during this stage, the trouble often being temporary and coming on towards the end of the day; hearing is affected more often.

The third stage is characterised by depression, loss of appetite and insomnia; visual troubles become more frequent, a fog comes before the eyes which is most marked in broad daylight. The pupil reactions remain. There appears to be no constant ophthalmoscopic change; pallor of the discs, slight neuritis, partial or complete atrophy, and normal discs have all been described. There is great lowering of central visual acuity, the scotoma being most marked for red and green; the peripheral fields are complete. The visual affection never occurs without well-marked general toxic symptoms.

When the sufferers are removed from the fumes, they recover slowly, but a relapse is certain if they resume the same work.

Of the cases investigated by the special committee, 33 per cent. recovered, 25 per cent. improved, and 20 per cent. showed little or no improvement; very similar figures were obtained by de Schweinitz.

[1] "Memoire sur les accidents que developpe dans les ouvriers en Caoutchouc l'inhalation du Sulfure de Carbone en Vapeur," Paris, 1856 and 1863.

NITRO-BENZOL.

This chemical is used in the manufacture of certain explosives, and during the process fumes are given off which in a few cases give rise to toxic symptoms, amongst which are affections of sight. Cases are reported by White,[1] Snell,[2] and others.

In addition to the inhalation of fumes, the chemical may enter the lungs as a fine dust, or may be absorbed through the skin.

The general symptoms of nitrobenzol poisoning include headache, muscular weakness, cyanosis, dilated pupils, rapid shallow respirations, and a thready failing pulse. The ocular symptoms are: diminished central acuity, contraction of the visual fields, and sometimes a colour scotoma. The ophthalmoscopic signs are a darker colour of the fundus than normal, venous hyperæmia, the veins being dark, full and tortuous, and pallor of the discs with slight blurring of their margins.

It is stated by Snell that the dark colour of the fundus occurs in those who work in the factories, even though their sight is not affected.

The prognosis is good if the patient is removed from access to the poison.

ANILINE.

The symptoms which arise from this compound, both ocular and general, are much similar to those which are caused by nitro-benzol. In addition, intense pigmentation of the cornea and conjunctiva may occur amongst workers in aniline dyes.[3]

CARBOLIC ACID.

A case of total blindness followed by complete recovery is reported by Nieden[4] in a man in whom the cavity of an empyema was washed out with a 3 per cent. solution of phenol.

[1] *Practitioner*, 1889, xliii., 14; and *Provincial Med. Jour.*, 1892, xi., 462.
[2] *Brit. Med. Jour.*, 1894, i., 449.
[3] Mackinlay, *Trans. Ophth. Soc. U.K.*, 1886, vi., 144.
[4] *Berlin klin. Wochenschr.*, 1882, xix., 748.

OCHRONOSIS.

The term "ochronosis" is applied to a burnt sienna-like coloration of the cartilaginous, elastic, and connective tissues of the body, and in some cases the triangular-shaped portion of the sclerotic at each side of the cornea as it appears in the palpebral fissure is involved in this coloration.

Albrecht showed that it occurred in the subjects of alkaptonuria; both it and the urinary abnormality may result from the prolonged external application of carbolic dressings to wounds.

In alkaptonuria the urine is normal in colour as it is passed, but it slowly acquires a deep brown colour, and ultimately becomes almost black. It is darkened by the addition of alkalies, and reduces Fehling's solution. Sir Archibald Garrod states that alkaptonuria is more common in males than in females, and that it dates from birth or early childhood. Its occurrence is not of any serious import.

NAPHTHALIN.

It was found by Bouchard, that if large doses of naphthalin were administered to rabbits, double cataract developed in the course of a week or two.

I have examined the eyes of several patients who under the care of Dr. J. H. Drysdale had been treated for leukæmia over long periods with considerable doses of naphthalin tetrachloride; in no case had cataract developed. A similar negative result was found by Burton in typhoid fever patients treated at the Alexian Hospital, Chicago, with the same drug for several weeks.

Peters [1] states that an increase of salts in the aqueous humour results from the administration of naphthalin, and suggests that the disturbance of osmosis between the lens and aqueous so produced is responsible for the development of lenticular opacities.

ANTIPYRIN.

This drug has caused temporary blindness in a few cases. Hotz [2] mentions four such; two patients went blind after

[1] *Trans. Heidelberg Ophth. Soc.*, 1902, 20.
[2] *Archiv. of Ophth.*, 1906, xxxv., 160.

taking 15 grains of the drug, one within five minutes, and one in twenty minutes ; both rapidly recovered. Another lost his sight in forty-eight hours after taking 130 grains ; the discs were pale and the vessels narrow ; complete recovery occurred.

De Schweinitz describes visual phenomena similar to those which occur as prodromata of migraine ; these effects he produced on himself by taking large doses of the drug.

SANTONIN.

Within a quarter of an hour of taking even non-toxic doses of this drug, everything within the field of vision is tinged a bright yellow, as if it were seen through a yellow glass.

Knies,[1] from experiments upon himself, found that a short period of violet vision preceded the yellow vision. He describes the colour as citron yellow ; occasionally green takes the place of the yellow colour. Rose [2] has made most elaborate investigations into this form of chromatopsia. According to Franceschi,[3] coloured vision occurs only if the drug is taken before being exposed to light ; if it is dissolved and exposed to light for twenty-four hours, the solution becomes yellow and does not then produce xanthopsia, but this is not in accord with common experience. Except where severe symptoms of santonin poisoning arise, there are no objective or permanent ocular effects.

ASPIDIUM (FILIX MAS).

This drug is usually given either in the form of a liquid extract or an oleoresin, as an anthelmintic. It is a violent gastro-intestinal poison and has caused death when given in excessive doses ; short of this, however, it has been responsible for a number of cases of loss of sight, 3 grammes of the extract given daily for twelve consecutive days having caused blindness (de Schweinitz).

[1] *Archiv. f. Augenheilk.*, 1888, xviii., 64.

[2] Quoted by de Schweinitz, Virchow's *Archives.*, xvi., 233 ; xviii., 15, 522 ; xx., 255 ; xxviii., 330.

[3] *Annales d'Oculist.*, 1861, xlv., 199.

Symptoms.—The symptoms are those of a violent gastro-enteritis with marked circulatory depression; blindness comes on from twenty-four hours to twelve days after the administration of the drug.

Katayama and Okamoto [1] collected twenty-three cases of poisoning, of whom ten suffered from temporary or permanent amblyopia; one or both eyes may be involved. Stuelp [2] states, that of forty-seven reported cases in which visual symptoms were present, they were noted as bilateral in nineteen, and as unilateral in seventeen.

Ophthalmoscopic reports vary a good deal; some observers have found the fundi normal in cases of blindness, some simply describe an optic atrophy. Stuelp examined a patient nine hours after the onset of coma from filix mas given for anchylostomiasis. He describes the whole fundus as covered with white œdema, the arteries as thread-like, the blood column broken, the veins tortuous and filled with broad and very dark columns of blood; blindness was complete.

De Schweinitz carried out experiements with this drug on dogs and rabbits without satisfying himself that blindness ensued, nor did he find any histological lesion in the eyes or optic nerves.

ARYLARSENATES.

In the early days of the treatment of syphilis by the arsenic compounds, some of them were found to be especially toxic, and a few cases of optic atrophy were reported from their use. Two such cases are reported by Clarke [3]; Beck [4] has published twenty-three cases of blindness from the use of atoxyl in sleeping sickness; and Birch Hirschfeld and Köster are stated to have found not only degeneration of the retina and optic nerve, but also of the external geniculate body. De Schweinitz remarks upon the absence of reports of visual disturbance in the numerous cases of arsenical poisoning, and

[1] Quoted by de Schweinitz, "Toxic Amblyopias," Philadelphia, 1896, 216.
[2] *Archiv. of Ophth.*, 1905, xxxiv., 229.
[3] *Trans. Ophth. Soc. U.K.*, 1910, xxx., 240.
[4] Quoted by Wray, *Trans. Ophth. Soc.*, 1910, xxx., 245.

states that he knows of no reported cases of amblyopia amongst the arsenic eaters of Styria.

I have seen changes develop in the optic nerve in two patients, with subsequent serious defect of sight, whilst novarseno-benzol was being administered for syphilis, with subsidence of the lesions on stopping the arsenic compound, and continuing with mercury.

Such inconclusive observations, it is clear, cannot substantiate the fact; at most they suggest the possibility worth bearing in mind, that the newer arsenic compounds may not be without danger to the vision.

ÆTHYLHYDROCUPREIN (OPTOCHIN).

This drug was first used by Morgenroth and Levy,[1] in the belief that it possessed a specific action on the pneumococcus. In a few cases of its use, eye symptoms have occurred. Fraenkel[2] had three such cases amongst twenty patients, and John Parkinson[3] had one amongst nine patients.

The symptoms in Fraenkel's cases consisted of amblyopia, which rapidly disappeared on stopping the drug, and in three of Parkinson's cases the pupils became widely dilated, but in none of them was amblyopia developed.

[1] *Berlin klin. Wochenschr.*, 1911, xlviii., ii., 1560, 1979.
[2] *Berlin klin. Wochenschr.*, 1912, xlix., i., 664.
[3] Parkinson, John, *Zeitschr. f. Chemotherapie*, 1913, ii., 1-10.

CHAPTER X

Cysticercus—Echinococcus—Trypanosomiasis—Malaria—Filaria Loa—Sporotrichosis—Actinomycosis.

CYSTICERCUS.

Many cases of the localisation within the eye of the cysticercus of Tænia Solium or Tænia Mediocanellata have been recorded.

According to Ballaban,[1] who collected 324 cases from the

Fig. 80.—An intra-ocular cysticercus. (D. J. Wood.)

literature, the commonest site for their occurrence is within the vitreous; beneath the retina is next most common, and they are least often seen under the conjunctiva.

[1] *Wien. Medizin Wochen.*, 1900, l., 2018 and 2070.

If the parasite is alive a striking appearance is often seen with the ophthalmoscope. A beautiful, globular, translucent cyst may be seen, its wall freely scattered over with fine calcareous granules, and movements of the contained animal may be visible (Fig. 80). Hill Griffith [1] says : " In each case one saw with the ophthalmoscope a large spherical bluish white cyst, and springing from this the neck of the animal, like an alabaster pillar surmounted by the head and suckers, which, with its slow, regular and graceful movements, reminded one of an elephant's trunk, the whole appearance presenting a picture once seen, never to be forgotten." Wood [2] describes a rather quick heaving movement which occurred about every fifteen seconds, followed by a slower subsidence. He says the appearance at its acme was as if something opened, and a sharply defined semicircle composed of tiny short radiating lines—evidently a part of the hook circle at the apex of the animal's head—appeared for a second or less and then subsided again into the general white mist. Rembe [3] saw a transparent cyst in the iris which underwent leech-like movements.

Schöbl [4] examined an eye histologically in which three separate cysticercus cysts were present.

If the animal dies, detachment of the retina and disorganisation and shrinking of the eye ensues. In a few cases the cyst has been successfully removed with retention of good vision.[5]

ECHINOCOCCUS.

Hyatid cysts may occur in the orbit or within the eyeball itself.

Intra-ocular.—The best description of this exceedingly rare condition is given by Werner.[6] The eye of a man aged twenty-eight was removed for secondary glaucoma. In the interior were a number of spherical opaque bodies which proved to be brood capsules. Excellent plates of micro photo-

[1] *Trans. Ophth. Soc. U.K.*, 1897, xvii., 220.
[2] *Trans. Ophth. Soc. U.K.*, 1901, xxi., 89.
[3] *Ophth. Record*, 1907, xvi., 20.
[4] *Central. für prakt. Augenheil.*, 1893, xvii., 191.
[5] Gomes, abstract *Jour. Amer. Med. Ass.*, 1919, lxxvii., 1945.
[6] *Trans. Ophth. Soc. U.K.*, 1903, xxiii., 103.

graphs, showing sections of the laminated cctocyst and ruptured brood capsules, accompany the description. The cyst was subretinal. At the time of Werner's paper two other cases only had been recorded, one by Gescheidt and one by Hill Griffith.[1]

Orbital.—Many cases of hydatid in the orbit are on record; they give rise to a slowly developing exophthalmus, which remains unchanged for a long time. They are more common in the young; thus of thirty-six cases collected by Lawford,[2] two only were over forty years of age; the average age was 20·1.

The rate of growth seems to vary a great deal. In a case of McGillivray,[3] exophthalmos had existed for six years, in Rockliffe's [4] for seven years, in Lawson's [5] for seven-and-a-half years, in Weeks' [6] for eight days.

TRYPANOSOMIASIS.

In this condition eye symptoms are common, and not infrequently they are the immediate cause of the patient seeking advice. The most usual manifestation is an irido-cyclitis, sometimes with pronounced œdema of the lower lid.

It was pointed out by Daniels [7] that the incidence of the eye lesions is in direct relation with the severity of the disease; thus in Rhodesian trypanosomiasis the eyes were affected in 83·3 per cent., in Nigerian cases 40 per cent., and in Uganda the incidence was only 18·7 per cent.; the mortality of the disease was nearly in this ratio. A good description is also given by Jellett. [8]

Some valuable experimental work was carried out on dogs by Woods and de Schweinitz.[9]

They found that in these animals infected with trypanosoma

[1] *Trans. Ophth. Soc. U.K.*, 1897, xvii., 220.
[2] *Trans. Ophth. Soc. U.K.*, 1895, xv., 172.
[3] Quoted *Annal. d'Oculistique*, 1866, lvi., 174.
[4] *Trans. Ophth. Soc. U.K.*, 1889, ix., 55.
[5] *Roy. London Ophth. Hosp. Reports*, 1882, x., 301.
[6] *Archiv. of Ophth.*, 1889, xviii., 31.
[7] *Proc. Roy. Soc. Med.*, 1915-16, ix., iii., Ophth. Sect., 2.
[8] *Ophth. Review*, 1915, xxxiv., 41.
[9] *Archives of Ophth.*, 1917, xlvi., 431.

equiperdum ocular complications were of constant occurrence. The cornea became cloudy, exudate appeared in the anterior chamber, and iritis with hæmorrhages developed. These lesions appeared synchronously with the invasion of the tissues by the trypanosome and seem to be dependent upon the actual invasion and not upon toxæmia. Trypanosomes invaded the substantia propria of the cornea and produced an interstitial keratitis, and in the iris and in the focal masses of cellular exudate overlying the retina the parasite was also present.

MALARIA.

There are no distinctive eye lesions of malaria, but an occasional retinal hæmorrhage is seen, and it has been pointed out by Kipp [1] that dendritic corneal ulcers are more frequent in this than in other febrile diseases.

FILARIA LOA.

The geographical distribution of this worm is limited to Congoland and Old Calabar on the West Coast of Africa.

It may appear under the integument in any part of the body, but with especial frequency under the skin of the eyelids or under the conjunctiva; never within the eyeball. According to Sir Patrick Manson it varies in length from 17 to 70 mm., the male being the smaller.

The parasite manifests itself by causing local irritation, and may be seen moving rapidly under the skin or conjunctiva.

Argyll Robertson [2] says "it is capable of wandering at will from one eye to the other, to disappear into the deeper parts of the orbit, to wander under the skin of the eyelids, and even to make excursions into the temporal region"; after removal, the worm presents the appearance of "a piece of fishing gut, being round, firm, transparent and colourless."

During cold weather it retires to the deeper tissues and causes no symptoms, coming towards the surface and appearing

[1] *Trans. Amer. Ophth. Soc.*, 1880-84, iii., 91; and 1880-90, v., 331.
[2] *Trans. Ophth. Soc. U.K.*, 1895, xv., 137.

under the skin or conjunctiva in warm weather or in a warm room.

If it is required to remove the parasite, its movements in the tissues are so quick that it is necessary to grip it through the tissues with forceps or to under-run it with a silk stitch, so as to fix it before making an incision.

In a case reported by Thomas and Parsons [1] a small round segmented worm 12 mm. long was seen lying on the iris. The eye was removed, and the head of the larva was submitted to Sir Arthur Shipley, who pronounced it to be either the maggot of a blow-fly or a *Sarcophaga Carnaria*.

SPOROTRICHOSIS.

A few cases of infection of the conjunctiva by the *Sporotrichum Beurmanni* have occurred.

The palpebral conjunctiva, the plica semilunaris and the lachrymal sac are most affected. Nodules appear which are usually small, but are sometimes of considerable size; Chaillous [2] describes some as being as large as a bean. These nodules break down to form greyish yellow ulcers with the formation of a good deal of pus. The preauricular, submaxillary and cervical lymphatic glands become much enlarged, and fever may occur.

It is a condition which is difficult of cure; thus Bedell [3] records a case of two years' duration, and Chaillous one of more than a year. Wilder and McCullough [4] report a case which occurred in a student engaged in investigating the condition which was completely cured in two months. In Bedell's case, several firm concretions were removed from the lachrymal sac from which the sporothrix was obtained on culture after crushing; Morax [5] also found it present in the lachrymal sac.

[1] *Trans. Ophth. Soc. U.K.*, 1909, xxix., 14.
[2] *Annales d'Ocul.*, 1911, cxlv., 47.
[3] *Trans. Amer. Ophth. Soc.*, 1912-14, xiii., 720.
[4] *Jour. Amer. Med. Assoc.*, 1914, lxii., 1156.
[5] *Annales d'Oculistique*, 1911, cxlv., 49.

ACTINOMYCOSIS.

Cases of external infection of the eye by actinomyces have been recorded, usually as a result of trauma.

The fungus was found by Orloff in two cases of corneal ulcer six weeks after an injury. Rosenhauch [1] reports a similar case following injury by a thorn, and also a case in which the conjunctiva was apparently infected by a coriander seed which had lodged in the sac.

In a case of miliary actinomycosis, Müller [2] found numerous nodules in the retina around the disc, which on examination were found to be composed of large epithelioid cells with poorly staining nuclei.

[1] *Klin. Monats. f. Augen.*, 1913, xv., 818.
[2] *Klin. Monats. f. Augen.*, 1903, xli., 236.

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